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Invention Needed for Automobiles. In the symposium on "Chemistry's Contribution to Automotive Transportation" at the Detroit meeting of the American Chemical Society, H. C. Mougey of the General Motors Corporation specified some problems in the field of automobile finishes that still remain to be solved by the chemist. Among these needed inventions are:

"A substitute for black baking enamel which will retain the advantages of low cost and ease of application but which will make the steel more resistant to corrosion under conditions of high humidity, and which will produce a film that holds its luster longer on exposure.

"Primers and surfacers for lacquer finishes, which will decrease the time of drying without increasing the cost of application.

"Some method of obtaining the smooth surface of high luster without the cost of the present system depending on hand rubbing and polishing."

Prof. D. B. Keyes of the University of Illinois said that the ideal anti-freeze compound for automobile radiators has not yet been reached. The three substances now most widely and successfully employed are alcohol, glycerine, and ethylene glycol.—*Science Service*

Step Towards Artificial Rubber Taken at Notre Dame University. The production of artificial rubber is apparently brought a step nearer by researches made at the University of Notre Dame reported to the American Chemical Society by the Rev. J. A. Nieuwland. Working in association with Daly and Sister M. Florentine he has found that a ninety per cent yield of ethylene chloride can be obtained by passing ethylene and chlorine gases into antimony pentachloride. The product can be readily converted into vinyl chloride by alcoholic potash.

This chemical reaction will seem unintelligible and unimportant to the general reader, but yet it may have a bearing on one of the most exciting commercial controversies of the day. For Plotnikoff proved in 1922 that vinyl chloride could be converted into rubber by the action of ultra-violet rays from an electric light. The electricity may come from water power which may also make calcium carbide of coal and lime. Adding water to the carbide generates acetylene gas which is easily made into ethylene. So the chain is complete from the waterfall to the rubber tire. But it is very questionable if rubber can be made in a factory as cheaply as it can be grown in a tree.—*Science Service*

Tuberculosis Vaccine to Be Tried on British Herds. The preventive tuberculosis vaccine that has been developed by Dr. Albert Calmette, director of the Pasteur Institute at Paris, is about to be tried out on herds of dairy cattle through the coöperation of the British veterinary ministry of health.

The vaccine is known as BCG, from the names of its discoverers, Dr. Calmette and Dr. M. Guerin of the Pasteur Institute at Lille. It consists of an attenuated strain of bovine tubercle bacilli that have, after years of cultivation on beef bile medium, somewhere in the succeeding generations lost their virulence, though they still apparently retain their power to confer immunity.

The vaccine will be used in selected herds in which tuberculosis is known to be present. All calves will be vaccinated within two weeks after they are born. The operation will be repeated every twelve months, over a period of five years. By that time most of the older and tuberculous cows will have been worked out of the herds. At the end of this period the herds will, it is expected, consist largely of adults that have been kept free from infection by vaccination.

Members of the staff of the health ministry will supervise the vaccinations to check up on the efficacy of this new method of attacking tuberculosis in cattle.—*Science Service*

M Berthelot

EDITOR'S OUTLOOK

Berthelot Centenary

FEW of us realize just how recently supernaturalism and mysticism departed from scientific thinking. We generally cite Wöhler's synthesis of urea as the death blow to the "vital force" theory in chemistry, yet that accomplishment long stood as an isolated incident and many and ingenious were the arguments advanced by the vitalists to explain it away. It remained for a man, the centenary of whose birth is to be celebrated during the latter part of this month, to pile synthesis upon synthesis until the total accumulation of evidence became overwhelming.

We are fortunate in being able to present at this appropriate time the excellent portrait of Marcellin Berthelot which appears on the opposite page and a rather comprehensive outline of his life, work and ideas. For both of these we are indebted to Dr. Avery A. Ashdown of the Massachusetts Institute of Technology.

At the Philadelphia meeting of the American Chemical Society, Dr. Paul Sabatier, perhaps the most distinguished of Berthelot's pupils, paid homage to his old master by selecting as the theme of his address an appreciation of the work of Berthelot and its influence on modern chemistry.[1] Dr. Ashdown recounts Berthelot's achievements in somewhat greater detail and, in addition, paints a portrait of the man which gives us a fuller insight into the qualities of mind and heart which secured to him the unanimous respect and affection of so many subsequently famous pupils.

The Detroit Meeting

IT MAY conservatively be said that the Detroit meeting of the American Chemical Society fulfilled the most optimistic expectations. Few of today's gigantic industries make a greater appeal to the general interest or have more points of contact with the science of chemistry than the automobile industry. Hence, it would be hard to find a convention city which could surpass Detroit in opportunities for attractive and profitable inspection trips. Furthermore, the local committees fully earned the numerous commendations which they received upon the completeness of their arrangements for the convenience and entertainment of the visiting chemists.

One feature of these arrangements seems worthy of especial mention. That is, the effort which was made to encourage student attendance. Through the efforts of Professor O. E. Madison of the College of the City of Detroit it was possible to furnish free housing to the first fifty students to apply and to accommodate later applicants at a nominal rate. We

[1] See THIS JOURNAL, 3, 1099–102 (Oct., 1926).

are thoroughly convinced that the convention-going habit is of immense benefit both to the organization and to the individual, and that its early cultivation should be encouraged in every way possible. We hope that future committees may see fit to continue and extend the student-housing plan.

The Division of Chemical Education also included in its program a series of events which seem to us worthy of perpetuation. These were the luncheons, at the last of which the high-school teachers of Detroit were guests. Since the luncheon recess is short it was thought best not to attempt a formal program but rather to leave the time available free for general conversation. That was a happy inspiration. The opportunities thus afforded to form new acquaintances and to renew old ones were unanimously welcomed. The atmosphere of spontaneous congeniality which prevailed bore testimony to the favor with which these gatherings were regarded.

To the constant attendant at meetings it is a truism unworthy of extended discussion that the social contacts and informal conferences which take place are among the pleasantest and most profitable experiences to be encountered there. The point too often forgotten is that there are at every meeting newcomers to the group who are naturally a trifle hesitant about making advances. The informal luncheon is one means of offering them an opportunity to become acquainted and of making them feel "at home."

Nor do we mean to imply that such affairs should be regarded purely as opportunities to "talk shop." Quite the contrary. It may not add greatly to one's fund of professional ideas to learn that the man on one's right indulges a passion for gardening and has some very sound ideas on the cultivation of hybrid teas or that the man on the left shares one's own love for a good sail-boat, but it is in a certain sense illuminating and it adds to the pleasure of the occasion.

However, to return to our resumé of events at Detroit, it is worthy of remark that the sessions of the Division of Chemical Education were exceptionally well attended. Throughout the first day the audience taxed to the limit the capacity of the auditorium in use and for the symposium on the popularization of chemistry on Thursday morning more commodious quarters were requisitioned.

The symposium and the discussions which accompanied it served to emphasize at least one point which has been brought forward elsewhere of late but which will bear some further discussion. That is, that we should look upon the popularization of chemistry as a task well begun but as one at which no more than a beginning has been made. Public interest in chemical developments has been aroused and public appreciation of the contributions which chemistry has made and is making to human

progress has been created, yet this appreciation is far from being of as intelligent a nature as we could wish. The man in the street is prompt to admit that the chemist is a clever fellow who has performed feats which stop not far short of the miraculous, and he confidently looks forward to further miracles from the same source. In short his faith in the future of the science is based not upon any reasoned evaluation of past achievements nor any logical consideration of the possibilities towards which they point, but upon the blind belief that hardly anything one may care to prophesy is more astonishing or incredible than the wonders he has already actually observed.

This attitude may be highly flattering but if recklessly encouraged it paves the way for ultimate disillusion and distrust. True, the American public is interested primarily in results, but once assured as to those results it is also capable of taking a keen interest in the means whereby they are attained. In the opinion of many—an opinion in which we concur—the time has come when we may with some hope of success attempt to inform the public as to how the chemist works as well as to what he produces.

Newspaper editors will continue to require that copy submitted for publication contain real news, yet it seems that even in the newspapers there is a field which has as yet been barely scratched. Many of the German papers include in their weekly supplements sections devoted entirely to science, just as our own Sunday papers conduct automobile, book, art, and fiction sections. Surely the average German newspaper reader is no better educated or more intelligent than his American counterpart, and if his interest in things scientific is of longer standing it is not necessarily any the keener for that reason.

But this is not the only possibility. The success of previous popular books on chemistry and the continued demand for such non-fiction as "The Story of Philosophy" and "Why We Behave Like Human Beings" should encourage some of our authors to undertake a more ambitious project than has heretofore been carried out.

Exposition of Chemical Industries

THE Eleventh Exposition of Chemical Industries which occupied three floors of the Grand Central Palace in New York during the week of September 26th to October 1st surpassed all previous records in number of exhibitors and in attendance. The "Court of Chemical Achievement," a feature of the Tenth Exposition, was not in evidence but a somewhat similar function was performed by the educational exhibits of the American Chemical Society and the various bureaus of the United States Department of Agriculture. Many of these were duplicated among the

commercial displays, indicating that they had safely passed the experimental stage.

Among the A. C. S. exhibits were samples of synthetic methanol manufactured by two distinct processes, samples showing ethylene glycol and its uses as an anti-freeze compound and lacquer plasticizer, a new rubber compound to replace solder in the sealing of cans, examples of chromium plating, viscose sausage casings, and solid carbon dioxide. An attempt to describe or even to enumerate the striking features of the Exposition in general would necessarily extend over many pages. Probably no product or display attracted more general attention than the solid carbon dioxide, the properties of which proved truly astonishing, particularly if one's expectations had been based upon a previous acquaintance with liquid air.

Registration in the student courses broke previous records and included men prominent in the profession as well as under-graduates. Dr. Harvey W. Wiley was among those enrolled. The student work was again under the direction of Dr. W. T. Read of Texas Technological College and was conducted in a manner which reflected credit upon him and upon the Exposition management. These courses have been developed by those in charge to a point where the full realization of their potentialities for service must wait upon recognition of the opportunities presented and coöperation by instructors. It is encouraging to note that this year more instructors than ever before accompanied their students and assisted in the handling of their own groups.

It is hoped that at future expositions the educational program can be extended to the high-school student and to the general public. Looking toward this end a conference of teachers of chemistry within the metropolitan area of New York was arranged for the last day of the Exposition. Nowhere else can the student or the layman acquire a clearer idea as to what chemical industry is and how it works, what tools it uses to meet the conditions imposed by economic considerations, and what products it turns out.

MARCELLIN BERTHELOT*

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The hundredth anniversary of the birth of Marcellin Berthelot will be appropriately celebrated in Paris toward the end of October of the present year. His contributions to the development of chemistry during the second half of the nineteenth century touched almost every phase of the science. Not only the discovery of new facts interested him. He looked beyond the data obtained, formulating the generalizations which were implied. "Whatever question you approach," Moissan declared at the jubilee in 1901, "you understand in its generalization." His philosophical bent led him to search out the significance of science in its broader bearing on the economic, political, and moral development of the race. His study of the oriental sources of alchemy put him in the front ranks of the historians of science. Besides his scientific activity he was deeply interested in public affairs. Almost alone among chemists he attained high rank in political life, serving the French government as senator for life, as minister of education in 1886–1887, and as minister of foreign affairs in 1895–1896.

The fruitful period of his scientific and literary career extended over fifty-six years. The results of his study and experiments were published in more than a thousand papers, besides approximately thirty volumes. Dr. Paul Sabatier, in reviewing the life and work of Berthelot, said of his old master, "His name will live as one of the greatest in chemistry and in science generally."[1]

Pierre-Eugène-Marcellin Berthelot was born in Paris on October 25, 1827. His mother was a Parisian but his father, a medical doctor, was born at Sologne.

> I was born in Place de Grève, at the corner of rue du Mouton, near the center of the left square of the Place de l'Hôtel-de-Ville, and facing the edifice. There, at the beginning of the last century, existed a house—a house with a history. It was the house of the lantern, at the time of the revolution. It belonged to my maternal grandfather. There, no one was hung and it hanged no one, although it served many. My infancy and my youth were passed at another house, that of ancient municipal authorities, situated in the rue des Ecrivains, opposite the court of Saint-Jacques-la-Boucherie.
>
> Today, however, I would not be able to find any object in these places with which to connect my memories. Of the two houses there remains not a stone, not a clod of earth. The very soil has perished. It was cut away in grading the rue de Rivoli, fifty years ago.[2]

* Paper read before the Division of History of Chemistry of the A. C. S. at Detroit, Michigan, Sept. 9, 1927.

[1] Sabatier, THIS JOURNAL, 3, 1099–102 (Oct., 1926).

[2] These places were destroyed when Haussmann's transformations of Paris were carried out.

There I was brought up, encircled by the love of my family and the traditions of republican France. There, too, in the midst of the barricades and the uprisings of the reign of Louis-Phillipe, of the revolution of 1848, and of the June Days, I heard the roar of the cannon and of the fusillade. Indeed, the first memory which I have of my earliest infancy, even at the most tender age, is that of the blood-stained wounded who had been hit at Saint Merri and at rue Transnonian. They were brought to my father for relief—who was a municipal doctor for thirty years and a friend of the people.[3]

In the lycée Henri IV, Berthelot, as a youth, pursued classical studies. At the same time he gave play to his natural taste for literature, history, and philosophy. Fouqué, one of his fellow students, speaking at the Berthelot jubilee, presented a beautiful picture of their school days.

The entire scientific world has classed you among its most illustrious members. Everyone admires your ability for working, your spirit of invention, your logic of ideas, your amplitude of memory, your experimental skill and your ability to pass from one series of researches to another series having no apparent link with the preceding. All these eminent qualities, united in the same man, assure him of an unrivaled personality, which I dare not qualify by a single word, fearing that I might wound your modesty. But I can affirm that these precious gifts, you already possessed in the germ when you were a simple school boy.

More than half a century ago we were seated side by side on the benches of the class in elementary mathematics of the Collége Henri IV.

Between us there was established an intimate comradeship. My memories bring back to me the charm of the long conversations we had on our studies and on all sorts of questions, even the most diverse. We followed with anxiety the events of that agitated period of our national history, and already you had taken for your motto, the sacred words, La Patria et La Vérité.[4]

During the time spent at the lycée Henri IV, the friendship of Berthelot and Renan was formed. It was destined to be one of those rare, fruitful associations which continue throughout life.

"It was in the month of November, 1845, that I saw Renan for the first time. He was four years older than I, but he had, perhaps, less experience with life than I, if it be permitted to speak of the experience of two adolescent youths."[5]

Our discussions (wrote Renan) were without end, our conversations always revived. We used to pass a part of the evening studying and working together. At the end of some time, Berthelot, having finished his mathematics at the lycée Henri IV, returned to his father's house, which stood at the foot of the Tour Saint-Jacques-la-Boucherie. Afterwards when he came to see me in the evening at the rue de l'Abbé de-l'Épée, we talked for some hours, and then I would accompany him back to the Tour Saint-Jacques. Ordinarily the question under discussion was far from being exhausted when we arrived at the gate, and he would lead me to Saint-Jacques du Haut-Pas. Then I would lead him back and these movements would be repeated

[3] Berthelot, "Science et libre pensée," p. 59.
[4] "Cinquantenaire scientifique de M. Berthelot," p. 24.
[5] Renan et Berthelot, "Correspondence," Introduction, p. 1.

several times. It was necessary that social and philosophical questions be very difficult indeed in order that we could not solve them in our desperate effort.[6]

At the lycée Berthelot had not come to a decision as to a career. He had been a brilliant student and must have entertained equal hopes for success in history, literature, or philosophy. He had won the "prix d'honneur de philosophie" at the close of his school days. Probably in imitation of his father his first choice of a life work was that of a doctor. He studied medicine for two years. But at the same time he began to frequent the Faculté des Sciences. Towards the end of 1849, when interest in chemistry was fast supplanting that in medicine, Berthelot began to work at the chemical laboratory of Pelouze in the rue Dauphine. It was there that he carried out his first published research, "On a simple process of showing the liquefaction of gas, without danger; and in particular of carbonic acid."[7]

Probably the external factor deciding Berthelot for the pursuit of chemistry was his appointment as assistant to Balard at the Collège de France. "Everything permits me to hope," Balard wrote to the minister in nominating Berthelot, "that M. Marcellin Berthelot will be able to utilize the position which I solicit for him, for the advancement of science." Balard showed the greatest attachment for Berthelot. "Up to his last days," Jungfleisch wrote, "Balard retained the highest estimate of the judgment and erudition of his old assistant, whose opinion he loved to know in difficult matters."

In April, 1854, Berthelot received the doctor of science degree for a thesis, "On the combination of glycerine with acids and on the synthesis of the immediate principle of the animal fats." This early research was among his most important because it inaugurated the long series of organic syntheses, one of his most outstanding achievements. In 1859 he became professor in the École Supérieur de Pharmacie, at the same time retaining the assistantship at the Collège de France. Two years later, at the instigation of a committee of professors led by Balard, Berthelot was appointed professor in the Collège de France. In 1865 the chair of organic chemistry was definitely created for him. He took possession of the laboratory in which he continued working to the end of his life.

On May 10, 1861, he was married to Mademoiselle Sophie Caroline Niaudet, a beautiful and cultivated woman. Their long life together was an unusually happy one. There were four sons and two daughters in the family.

The war of 1870 stirred in Berthelot the republican spirit which he had inherited from his father. The children safe in the south of France, he threw his energy whole-heartedly into his work as chairman of the

[6] Renan, "Souvenirs d'enfance et de jeunesse," p. 333.

[7] Berthelot, *Compt. Rend.*, **30**, 666 (1850).

Scientific Committee for the defense of Paris. The origin of his public life lay in his activities on this committee. They won the admiration of the French people. During the rest of his life he devoted a good deal of his energies to the state. Such a course was in accord with his own expressed views.

"In a republican country, the duty of a savant is the same as that for all other citizens. He owes a part of his thought and his activity to the direction of public affairs. He owes his personal effort to the progress of humanity. This duty is even more binding, perhaps, for the savant than for other citizens, because of his intelligence and his superior capacity."[8]

Undoubtedly the spirit here manifested largely accounted for his willingness to serve as minister of education in the cabinet of Goblet in 1886–1887 and again as minister of foreign affairs in the cabinet of Léon Bourgeois in 1895–1896.

The honors tendered to M. Berthelot were almost without number. They included prizes, medals, election to practically every scientific society of importance in Europe as well as the highest scientific honors in the power of France to bestow. Of all these none equaled in grandeur the jubilee in Paris on November 24, 1901.

In the great hall of the Sorbonne, according to Graebe, 3800 people had assembled to pay homage to the master. The president of the republic, M. Loubet, presided over the illustrious assembly of members of the French government and of the parliament as well as many notables, foreign delegations, the colleagues of Berthelot, his students, young and old, and the members of his family. "Never before," wrote Graebe, "had the masterpiece of Puvis de Chavanne, the Sacred Grove, looked down on so distinguished a company." M. Leygues, minister of education, opened the meeting. Then followed notable addresses by Barboux, Fouqué, Moissan, Gaston Paris, Guyon, Chaveau, and Bouchard. There were many notes of congratulations from foreign societies. In all 140 speeches and addresses were offered in tribute to the master. "To whomsoever might be surprised at your enormous scientific production," said Moissan, "you might well reply, as did Faraday, 'The secret may be summed up in three words—*travailler*, *terminer*, *publier*—work, finish, publish.' "

In response to all the honors paid him, Berthelot, then seventy-five years of age, made a speech ringing with his convictions on the dignity of science and on the relation of the scientist to the life of the times about him and to the larger life of the race. His noble definition of science brought forth prolonged applause. His speech follows, in translation.[9]

[8] Berthelot, "Science et Morale," p. 269.

[9] The speech is published in *Revue Générale de Chimie Pure et Appliquée*, 4, 630 (1901) and in "Cinquantenaire scientifique de M. Berthelot," p. 75.

Mr. President,
Mr. Secretary,
My dear confréres, colleagues, and friends,
And you, young men, my students and my friends,

I am profoundly touched and truly confused by the homage which you pay me at this moment. The honors, I take it, are not due solely to your affection for me personally. I feel compelled to refer them alike to my age, my long period of work, and to those services which I have been able to render to my country and to my fellowmen.

First, with respect to my age; your sympathy causes its lamp, on the point of going out into eternal night, to be brilliant with a last flash of light. The respect which humanity gives to the aged is the expression of the solidarity uniting the present generations with those which have preceded us, and with those which shall follow us.

In fact, that which we are, is attributable in but small part to our labor and to our personal individuality. We owe almost everything to our ancestors of blood and to our ancestors of the spirit. If each of us add something to the common domain, in the realm of science, of art, or of morality, it is because a long series of generations has lived, worked, thought, and suffered before us. The patient labors of our predecessors have created this science which you honor today.

Each of us, whatever has been his individual initiative, also ought to attribute a considerable part of his success to contemporary savants, concurring with him in the great common task.

In truth, the discoveries, so brilliant in the past century, the discoveries, let us declare it from the heights, for them no one has the right to claim the exclusive merit. Science is essentially a collective work, continued during the course of time by the efforts of a multitude of workers, of every age and of every nation. In succeeding one another, they are associated, by virtue of a tacit entente, in the search of truth for its own sake and for its application to the continued transformation of the conditions of all mankind.

In former times, one envisaged the savants as a small group of devotees and of men of leisure. They were pictured as maintained at the expense of the working classes, and executing a work of luxury and of curiosity, for the amusement and the diversion of those favored by fortune. This view, narrow and unjust, contained but little account of our devotion to truth and of our services. It was destined to disappear when the development of science showed that the laws of nature were applicable to industrial practice and that profitable rules and theories, founded on observation and experiment, could be substituted for old traditional and empirical recipes.

Today, who would still venture to regard science as a sterile amusement, and stand in the presence of the general accretion of national and private wealth which has resulted from it? To limit ourselves by citing, perhaps the most interesting of the services which science has rendered, it will suffice to compare the servile and miserable conditions of the popular masses in the past, as set forth in historical documents, with their present condition. They are already greatly elevated in dignity and in well-being, without prejudicing the just hopes whose realization they pursue. Is there a statesman who doubts the still greater services which one ought to expect from unceasing progress? Science is the benefactress of humanity.

See how the tangible utility of scientific results has explained to the public authorities that the work of the laboratories ought to be encouraged and sustained because it benefits everything in the economic order and in the realm of the public health. But that is only a portion of our domain. Science raises higher her legitimate pretensions. Today she demands at once the material direction, the intellectual direction,

and the moral direction of society. Under her impulse modern society marches with a step more and more rapid.

Since the first half of the century which has just closed, without going back very far, the world has strangely changed its figure. The men of my generation have seen enter into play, in addition to and above nature as known since antiquity, if not an antiphrasis, then a contra-nature, as is said sometimes. But it is a nature superior and in some manner transcendent, where the power of the individual is multiplied a hundredfold by the transformation of forces, hitherto ignored or not understood, forces borrowed from light, from magnetism, and from electricity.

That is not all. Let us elevate ourselves to an order of ideas higher and more fertile. From the more profound understanding of the universe and of the physical and moral constitution of man will come a new conception of human destiny. It will be directed by fundamental notions of the universal solidarity between all classes and all nations. In proportion as the bonds that unite peoples are multiplied and drawn tighter by the progress of science and by the unity of doctrine and precepts which she deduces from established facts and imposes on all convictions without violence, but none the less in an irresistible fashion, the notions of science have assumed a growing importance which is more and more compelling. They tend to become the purely human basis of the morals and politics of the future.

By the same token the rôle of the savants, as individuals and as a social class, has grown without ceasing in modern states. At the same time our duties towards other men have grown. Let us never forget it. Let us proclaim it in this hall, in this palace of French science. It is not for the egotistic satisfaction of our private vanity that the world, today, pays homage to the savants. On the contrary, it is because the world knows that a savant, truly worthy of the name, consecrates a disinterested life to a great work of our epoch. I want to say, to the amelioration, too slow, alas, to our liking, of the fate of all, from the rich and the happy to the humble, the poor and the suffering. Witness the declarations of the public authorities nine years ago in this same hall, when they were honoring Pasteur. Witness the ideal which my friend Chaplain has sought to express in the beautiful medal which the president of the republic is going to offer to me. I do not know whether I have completely fulfilled the noble ideal which the artist has traced. But I shall endeavor to make it the object, the end and the guiding goal of my existence.

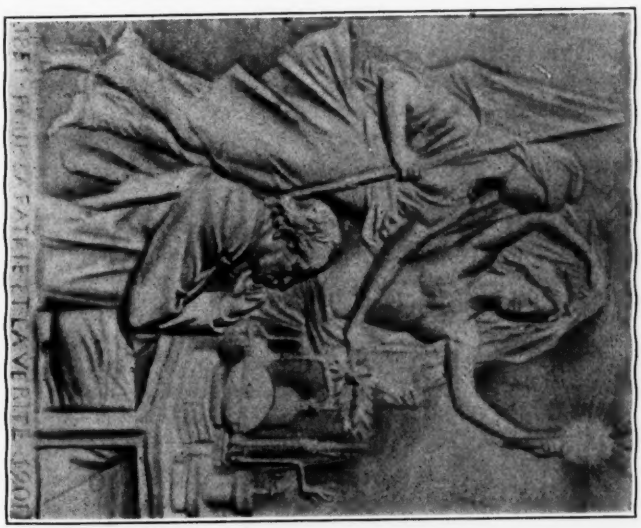
* * * * * * * *

Berthelot pronounced his oration in a voice at first showing profound emotion. By degrees it grew more calm and at the end was clear and distinct. . . .Each sentence of the remarkable discourse was greeted by applause which ceased only to be re-kindled by the succeeding phrases. His concluding words aroused general enthusiasm. The thousands of hearers rose and long acclaimed the savant who had just given a most noble and humane definition of science.

The applause was prolonged when the president of the republic stood up and turned to Berthelot to embrace him and, in the name of all, give him the commemorative medal. . . .Berthelot was clearly under a great strain of emotion as he bowed to the chief of the state and to the thousands of French people and foreigners who brought him the homage of humanity.[10]

The medal of Chaplain is worthy of the man it honors. On one side is a bust of the master. Above it stands his name, MARCELIN BER-

[10] "Cinquantinaire scientifique de M. Berthelot," p. 78.



BERTHELOT MEDAL BY CHAPLAIN

THELOT.[11] Beneath the bust are the very appropriate words, LA SYNTHÈSE CHIMIQUE, LA SCIENCE GUIDE L'HUMANITÉ.

On the reverse side Berthelot is shown seated in an ordinary chair before a table holding the apparatus for the synthesis of acetylene. He is represented in a very characteristic pose, his right hand holding his left elbow, his left hand supporting his chin. His eyes are gazing ahead into the distance beyond the things on the table. He is absorbed in meditation. Two upright female figures, symbols of guiding spirits, are above him. The first, "LA PATRIA," carries a flag in one hand and extends a laurel branch in the other. The second figure, "LA VÉRITÉ," holds aloft in her left hand a scintillating mirror of truth.

For six years longer, Berthelot continued his work with accustomed vigor at the Collège de France and at the agricultural experiment station at Meudon. He died in Paris on March 18, 1907, only a short time after Mme. Berthelot, whose declining days he had most faithfully watched The nation honored the dead leader by a great state funeral in the Panthéon. The family was unwilling that M. and Mme. Berthelot should occupy separate graves, since not even death had parted them. Accordingly an exception was made and for the first time a woman was buried in the Panthéon.

The Scientific Work of Berthelot

Probably the first impression conveyed to the student beginning to examine the complete bibliography of Berthelot's work, which Jungfleisch prepared, is the enormous number of publications.[12] In the year 1880 alone, there were more than eighty articles. The total number of papers reached more than 1000. Besides them, there were about thirty books. Berthelot was one of the most prolific scientists of the nineteenth century.

A reading of the titles of his papers shows that there were several well-defined fields of research. As has been pointed out earlier, his first paper in the field of organic chemistry, the preparation of vegetable fats by making the corresponding esters of glycerine, was the fore-runner of the syntheses of a great variety of organic compounds from the elements.

Of these syntheses, acetylene may serve as an outstanding example. Studies on this compound were begun about 1858. To produce it by arcing between carbon electrodes in an atmosphere of hydrogen was a triumph of the chemical laboratory. With acetylene made from the elements, the inorganic genesis of almost an infinite number of organic compounds was established. These researches went further, demonstrat-

[11] Throughout all the earlier part of his life Berthelot had written his name Marcellin. In later years he had used Marcelin or simply M.

[12] Jungfleisch, *Bulletin Société Chimique* (IV) **13**, CLVII (1913).

ing that the same laws of combination which were known for the inorganic world applied to the organic compounds. Likewise the principle of "vital force" became an unnecessary explanation of their formation. Wöhler's synthesis of urea in 1828 was really only the first ray of light on the problem. It was an isolated case. It is true that Kolbe had worked out a preparation for acetic acid from inorganic sources, but chemists in general were not convinced. Berthelot led the way to those great studies in synthesis which so enhanced the prestige of organic chemistry during the nineteenth century.

The early work on the fats led almost at once to the discovery of the time factor in a reaction. The formation of the fats was, in one sense, a study in esterification. Berthelot observed that an appreciable amount of time was necessary for the products to be formed. Furthermore, he noticed that the rate of formation became slower and slower as the concentration of the reactants decreased. Out of these studies came far-reaching conceptions on rate of reaction and mass action. Berthelot and his co-worker, in this instance Péan de Saint-Gilles, thus became pioneers on the experimental side of chemical statics and dynamics.

Berthelot's contributions to the development of physical chemistry are nowhere better shown than in his work in thermo-chemistry. Almost contemporaneously with Julius Thomsen, he set himself the task of measuring the heat changes involved in chemical reactions. He had devised the bomb calorimeter for carrying out the combustions of explosive compounds and now he proceeded to use it for determining heats of combustion and of reaction generally. The result was an enormous amount of thermo-chemical data. Indeed it used to be said that if the heat of a reaction were needed it should be sought in the works of either Berthelot or Thomsen. From these studies came the enunciation of the principle of maximum work, namely: every chemical change which proceeds spontaneously strives to form those compounds or systems of compounds which are accompanied by the evolution of the most heat. In spite of the inadequacy of the theorem as was shown later by the researches of Helmholtz, Gibbs, van't Hoff, and others, it still has a general qualitative value.

The experiences of Berthelot in the war of 1870 naturally gave him great interest in explosives. His studies in this field of chemistry led him to the very important discovery of the explosion wave. He applied the term to the movement of the flame at its highest velocity through an explosive gas mixture. In the study of the decomposition of many explosive substances, he observed a peculiar undulatory motion characteristic of such reactions. He found that this wave motion attained a maximum velocity, independent of the pressure of the gases involved, of the material of the tube in which the reaction was carried out, and,

within limits, of the diameter of the tube. In other words, the explosion wave was a new chemical constant. Some idea of the magnitude of Berthelot's work on explosives may be gained from the fact that the third edition of his book on this subject, published in 1883, had grown from the brochure of 1871 into two volumes of more than 400 pages each.

Berthelot's interest in agricultural chemistry dated from 1876 when he discovered the union of nitrogen with organic compounds. He found that certain carbohydrates, cellulose, for example, under the influence of the silent electric discharge absorbed nitrogen, either pure or atmospheric. By heating with lime the absorbed nitrogen was liberated as ammonia. An old question assailed him anew, namely: how was the nitrogen of the air made available for plant life? In the course of his study of this question he observed that soil which was supporting growing plants slowly absorbed nitrogen. This phenomenon, he found, did not take place in winter but was most active when the plants were at the height of their period of growth. The entire absorption was stopped by heating the soil to 100°C. These data led him to postulate that there were microörganisms in the soil having the ability to absorb nitrogen. Confirmation, by other workers, of the rôle of nitrifying bacteria in the nitrogen cycle in the economy of nature, was not forthcoming for several years. At Meudon, not far from Paris, an agricultural experiment station was built for him in 1883. There he carried out researches in plant chemistry to the end of his life.

Among Berthelot's other contributions to experimental science were studies on the liquefaction of gases, the partition of a substance between two immiscible solvents, the use of hydrogen iodide as a reducing agent, the theory of fermentation, the origin of petroleum, and the behavior of hydrocarbons when subjected to high temperature.

Contributions to the History of Chemistry

In 1869 Berthelot attended the opening of the Suez canal and combined with the journey an extended visit to Egypt. The specimens which he examined of ancient metals, glass, pottery, and so forth, made a great impression on him, which prompted him to search out the sources of the chemical knowledge of ancient days. In the long run his researches in the history of chemistry carried him far back into the manuscripts of ancient Greece, Rome, and Arabia. He was a competent Greek and Latin scholar but for the oriental languages he had the help of scholars versed in eastern tongues. These researches placed Berthelot in the front rank of historians of chemistry, himself a great figure in that history.

The results of his historical researches were published in several large volumes. "Les Origines de L'Alchimie" appeared in 1885. Chemistry

was shown not to have been a primitive science like astronomy. On the contrary it had grown out of a mass of practical discoveries in medicine, in metallurgy, and in industrial and domestic economy handed down from very ancient times. "Introduction a L'Étude de la Chimie des Anciens et du Moyen Âge," published in 1889, contained an extended development of the studies on the origins of alchemy. In it was also a complete translation of the Leyden Papyrus X.

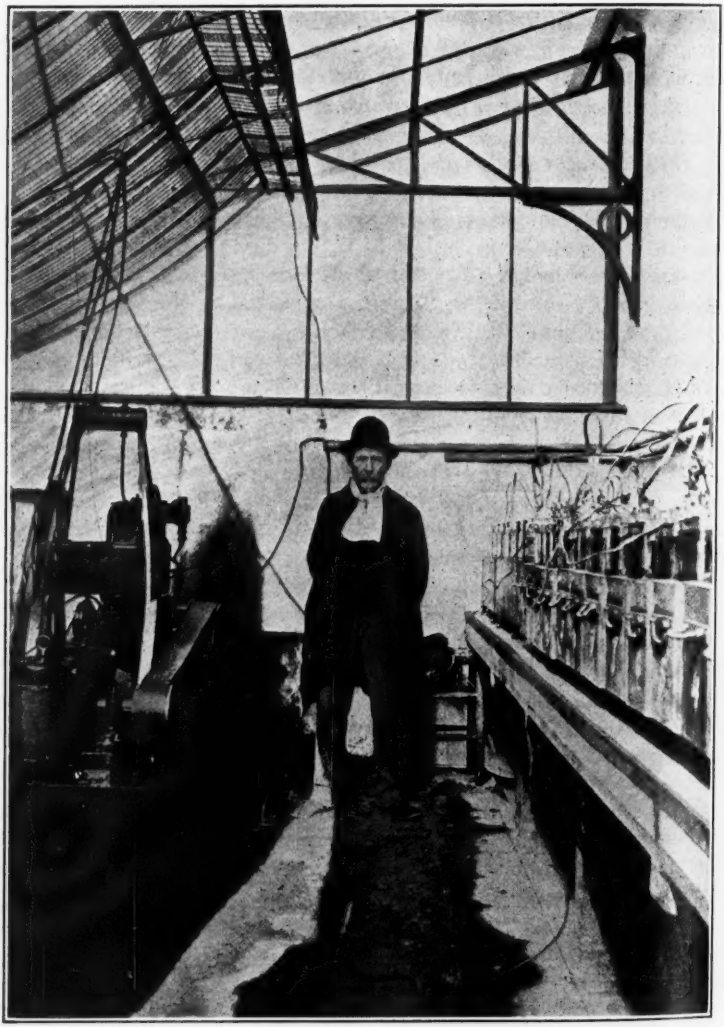
Probably "La Chimie au Moyen Âge," published in 1893, constituted Berthelot's greatest contribution to the history of chemistry. It was in three large volumes. The first dealt with the means by which the chemistry of the Alexandrine Greeks had passed to the western world. The second volume, "L'Alchimie Syriaque" showed how Syria had been an intermediary between the Greeks and the Arabs. In the final volume, "L'Alchimie Arabe," the Latin writings of Geber were shown to be fabrications of the thirteenth to fifteenth centuries. In reality the authentic Arabic writings contained nothing not already known to the Greeks.

There were also several other important volumes dealing with the history of chemistry. In a book entitled "La Révolution chimique Lavoisier," Berthelot turned his attention to the history of modern chemistry. The immediate occasion for writing the book was the centenary of the French revolution coincident with his election as permanent secretary of the Academy of Sciences. He decided to begin his duties by presenting an historical sketch to the academy. The book grew out of this short paper. It traced mainly the development of Lavoisier's scientific ideas. Only a very short section was biographical. It contained copies of Lavoisier's original manuscripts which had never been published.

The last work in this field, "Archéologie et Histoire des sciences," was published in 1906, the year before Berthelot's death. It contained the studies which he had made on ancient metallic objects at various times during his life. In it were also copies of the originals of two important manuscripts. The "Leyden Papyrus X" was given completely in the Greek and the "Livre des 70" in the Latin. The latter book Berthelot thought to be a translation of an authentic Arabic text which had been lost to the world.

Philosophical Outlook of Berthelot

Of Berthelot it could not be said that a great plane of cleavage separated his philosophical views on life from his scientific work. For him the universe was an integrated system. The organic and the inorganic were not divided by a great abyss but operated according to definite laws which science discovered and interpreted. His own researches indeed had shown how innumerable compounds, produced by plant



BERTHELOT IN HIS LABORATORY

and animal life, could be duplicated in the laboratory. Quite in accordance with his work he believed that science, founded upon the observation of facts and upon experiment, could know no insurmountable barriers. The claims of science would thus ever expand to the limits of human experience. Even the moral and political life of mankind would find

science in possession of the means for attaining greater perfection. "Science is the benefactress of humanity," he had declared at the jubilee in 1901.

In his scientific work he emphasized strongly the necessity of distinguishing between the facts and their interpretation. He was skeptical of the value of theories. Such an attitude of mind probably went far in accounting for his long-continued use of the older formulas for compounds. As late as 1890, forty years after Williamson's synthesis of the unsymmetrical ethers had settled the formula for water, he was still writing the symbol for that compound as H_2O_2. For him equivalent weights were indisputable facts but atoms were as fabrications of the mind. Berthelot has been accused of retarding chemistry by his stand in this matter. However, reflection on many similar cases in the history of science suggests that such an interpretation is incomplete. Bunsen never gave up the old notation. Priestley stood by phlogiston even to the end of his days. Aggassiz never accepted the theory of organic evolution. Wilhelm Ostwald long opposed the kinetic point of view in science.

There came a day when Berthelot no longer persisted. The story of his change of mind in favor of the present-day symbolism has been variously told though nowhere more dramatically than by Ramsay.

"Professor Guye, who attended his lectures in 1890–1891, tells that the session was begun, as usual, with the special notation of which Berthelot was the sole defender ('equivalents based on two volumes of vapor'), and that, without the slightest warning in the middle of a chapter, to the great astonishment of his audience, he effected the change, dealing with a subject of which the first portion had been expounded in the 'equivalent' notation, and continuing in the newer notation of which he had so long been the opponent."[13]

Personal Traits

Berthelot made a marked impression on his associates, many of whom have penned word pictures of him.

Louguinine, who went to his laboratory in 1869, described him as follows.

"Berthelot made an extraordinarily vivid impression on me. He was in the full powers of manhood. Although, even then, he walked with stooped shoulders, he was full of life and energy. He possessed an unusual wealth of general ideas of methods for overcoming the difficulties which arose in the course of his researches."[14]

Dixon described him as an inspiring teacher.

"Those who met Berthelot in his prime could not but be struck with

[13] Ramsay, *Royal Soc. London*, **80A**, iii (obituaries) (1908).

[14] Graebe, *Ber.*, **41**, 4813 (1908).

the intellectual sincerity and the intense enthusiasm of the man. The broad forehead, the brilliant blue eyes, the clean-cut features, and the thoughtful expression impressed all who saw him; while his musical voice and clear enunciation charmed the ear. It would be impossible to forget that first impression.

"Students who attended his lectures speak in the highest terms of the inspiration they drew from his teaching. He gave of his best, and delighted to show his audience the new experiments he was engaged upon. But it was when he forgot the immediate experiment in hand, and began to think aloud, that the inspiration was highest. Here truly was science 'in the making.' "[15]

His attitude against capitalizing his science is emphasized by the fact that he never took out a patent. He often insisted on the disinterestedness necessary to the savant.

"He used to recall with pleasure an old legend of the Middle Ages about the alchemists and sorcerers; possessors of a magic talisman, the power of which was extinguished in their hands as soon as they attempted to derive a personal profit from it. . . . The breweries of northern France insisted repeatedly that he give them the monopoly of one of his discoveries. Constantly he slipped away from their solicitations. He worked only for science.[16]

"One fact shows clearly how Berthelot had preserved an uncommon activity of mind up to his last days.

"In 1906, the year preceding his death, he published three volumes, the first edition of his 'Traité de l'analyse des gaz,' the second edition of the collection 'Science et Philosophie,' and the 'Archéologie et Histoire des Sciences.' This last volume was a reproduction of a long work inserted in the 'Mémoires de l'Académie' in the same year. During the same period he published eight notes in the *Comptes Rendus* of the meetings of l'Académie des Sciences, eight memoirs in the *Annales de Physique et de Chimie*, and an article on the history of chemistry in the *Journal des Savants*."[17]

In his home life, Berthelot exhibited the highest domestic virtues. "It was especially in the midst of his family that he manifested the depth of his emotions, generally so delicately guarded. The great savant knew how to be the most captivating of grandfathers. He always had boxes of bonbons in his pockets, not synthetic bonbons, but real, authentic ones from the candy shop, which were the delight of his little grandchildren."[18]

[15] Dixon, *J. Chem. Soc. London*, **99**, 2360 (1911).
[16] Boutaric, "Marcellin Berthelot," Payot, Paris, **1927**, pp. 194–195.
[17] Jungfleisch, *Bulletin Société Chimiques* (IV) **13**, CLVI (1913).
[18] Boutaric, "Marcellin Berthelot," Payot, Paris, **1927**, p. 218.

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Present Age Declared the Age of Chemistry. Previous ages of man's history have been known as the Age of Stone, the Age of Bronze, the Age of Iron, and so on. The present time is preëminently the Age of Chemistry.

This was the thesis of the presidential address delivered before the American Chemical Society at its principal general session by Dr. George D. Rosengarten of Philadelphia, head of the society during the present year.

Even in the past, chemistry played a leading part in man's progress, Dr. Rosengarten declared, though man has not always been conscious of its importance. The change from the Age of Bronze to the Age of Iron, 3000 years ago, was largely a chemical change.

The task of the present and the immediate future, he told his hearers, is the full mastering of the basic principles of chemical science.

"An important problem and one requiring our immediate and undivided attention is so-called 'pure chemistry.' I should rather like to call it 'science of chemistry' in contradistinction to the practical application of chemistry which would be more correctly designated as the 'art of chemistry.'

"Pure science is the protoplasm of applied science. It is the brick and mortar of our sky-scraping buildings of industry and commerce. Our civilization of which we are so proud, the comforts of life we are enjoying are wholly built on discoveries emanating from the search for scientific truths, from the pursuit of science for the sake of the science itself. As Secretary Hoover has very tersely put it: 'It is in the soil of Pure Science that are found the origins of all of our modern industries and commerce.'

"The relationship between the science of chemistry and its varied and multitudinous applications is quite apparent to the chemist, but for our lay guests let me cite one or two of the thousands of examples. About one hundred and twenty years ago, Sir Humphrey Davy in his pursuit of scientific knowledge for the sake of knowledge discovered a method of separating the 'refractory' metals, potassium and sodium, from their combinations. Based on this fundamental discovery, Hall, an American, and Heroult, a Frenchman, prepared the metal, aluminum. But for the availability of this metal, aviation would still have been a Midsummer Night's Dream.

"This metal has also added immensely to family happiness. Aluminum kitchen utensils are easy to wash and keep clean, making less work in the household, and consequently stabilizing domestic felicity.

"We are living on the scientific researches of a hundred or more years ago. We are plucking the fruit of trees of knowledge planted by our forbears. We have worked hard and fast to get all we can out of the funds of discoveries of past centuries, but we cannot much longer go on harvesting without planting. We owe to posterity what past generations have provided for us. We must not fail in our duty, we must not go back on our indebtedness."—*Science Service*

SYNTHESIZING A CHEMICAL TERMINOLOGY IN CHINA

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Chemistry is being re-introduced into China and a chemical terminology is being created to aid in making the newly imported science thoroughly indigenous. The accompanying account suggests the difficulties encountered and the principles followed in fixing a Chinese chemical terminology.

Systems of scientific terminology are usually not created; rather they are developed. In the Occident, scientific knowledge, as it grew, selected from the European national languages well-used terms which it re-defined, nourished, and drew into itself. The fullness of meaning which each term now conveys to us is a reflection of the history of the science and of its successive discoveries. In the Orient, and in China in particular, however, it became necessary to deliberately create a terminology. The introduction of western knowledge and western science came upon the country as an over night *coup d'etat.* The demand upon the language medium was correspondingly violent. The need suddenly arose for giving the newly imported sciences a medium of expression which the old picturesque Chinese literary ideograms did not naturally supply.

We do not usually appreciate the extent to which western science has grown hand in hand with the language medium. Each enriched the other. We do not normally stop to realize how much the English language of today retains the color and flavor of the sciences which use it; nor do we realize to what extent our sciences should be grateful for having been born into a language which was fertile soil.

The modern China is nationalistic. Chemistry has been required to find an indigenous method of expression. While it is permissible to import chemical knowledge from the west, new China insists that at the port of entry it should be outfitted as far as possible in Oriental garb. But Chinese is not a phonetic language; it has few if any points in common with the European language systems, and western names cannot be readily transliterated by sound as can be done in Japanese. A genuine process of translation and direct synthesis became necessary. Moreover, since the Chinese language in daily use does not naturally adapt itself to the expression of accurate scientific ideas, a certain amount of re-definition also became necessary. The thought that English should be made the scientific language of China was seriously proposed up until a few years ago, but this it now appears was only a fleeting illusion which the recent flood of new nationalist ideals has rudely swept aside. To such an extent has modern science become associated in the Anglo-Saxon mind with the Latin alphabet and with Indo-European sound structure that it is

difficult to think of chemistry and physics divested of this language medium. It is, of course, quite possible for our sciences to retain all their best qualities when transposed into the language of another race, or into the language of the people on the moon if we please. And this is exactly the transformation that is taking place in China.

A few early attempts at creating a chemical terminology in Chinese were made by enthusiastic missionaries who were good linguists but poor chemists. Thus in the first chemistry text published in Chinese about 1870, a book which resembles the old dictionary type of college text, the general name for a salt was translated by a word meaning *alum* in Chinese; thus soda became *sodium carbon alum*. The higher valence acids were *strong* acids, and those of lower valence were termed *weak* acids. In one of the textbooks still in use ten years ago $KMnO_4$ carries the startling cognomen *extra strong manganese alum of potassium*. Other equally fantastic labels resulted from these first attempts.

These early efforts at supplying a terminology were followed in 1915 by the organization, under the auspices of the Ministry of Education, of the General Committee on Scientific Terminology, which is responsible for the present attack upon the terminology problem. The personnel of this General Committee is composed of representatives from the different scientific societies in China including the National Medical Association, the China Medical Association, the Chinese Pharmaceutical Society, and the Science Society. Sub-groups, each consisting of about ten or fifteen members, were organized upon different subjects—chemistry, botany, anatomy, etc. The writer had the privilege of being one of two foreigners in the chemistry section sitting with Chinese chemists trained in Europe, America, Japan, and China. The viewpoint of the committee has been a truly international one. The larger General Committee meets annually, and at the present date most of the fundamental terms for all the sciences have been standardized, and formally confirmed by the Chinese Ministry of Education.

Certain principles have been followed in carrying out this terminology task. First, it was early decided to avoid if possible the invention of new characters, as the letters of the Chinese alphabet are called. The Chinese language already has an alphabet of approximately 80,000 characters; it seemed unwise to add unnecessarily to this collection. When a strictly new term not existing in Chinese was needed, recourse was had to the host of old characters which had fallen into more or less disuse. One of these was simply resurrected and given a new lease of life. This reserve stock of characters was a great convenience in that it gave an opportunity to define these terms anew instead of having to combat a loose and inaccurate meaning in a more commonly used word or phrase.

Second, it was deemed wise to avoid the transliteration of western sounds. The transliteration into Chinese of western sounds is sometimes undertaken, but as many of the sounds which make up the English language do not occur in Chinese, and vice versa, the result is at best an awkward and distasteful hybrid. In English, when necessary to quote a Greek name, for example, it is considered preferable to insert the Greek word in the original Greek characters. The same principle is followed in scientific Chinese, *i. e.*, the European proper name is spelled out in full.

A third principle in the terminology work recognizes that the symbols for the chemical elements as commonly expressed in Latin letters

FIG. 1.—Chinese characters for some of the chemical elements. Many of these names are prehistoric; the same principle illustrated above has likewise been followed in manufacturing new ideograms for the newer elements.

are international by definition. This accounts for the fact that in Chinese the formula for common salt is also written *NaCl*.

The European languages are able in emergency to revert to Latin and Greek for the coining of new scientific terms, and they seize this opportunity on the least provocation. Chinese is equally rich in classic roots; a classical language has existed alongside the common language for two thousand years or more. Malic acid, then, for example, is not translated into Chinese so as to appear, plebeian-like, *apple acid;* but in its Chinese term it also retains the classic flavor of *malic* acid with all the refinement which a literary epicure could desire.

In recording the success of the efforts which have been made in fixing a scientific terminology in Chinese, a tribute is due to the help which

has been derived from the Japanese scientific vocabulary. There are many points of similarity between the Japanese and Chinese languages. But science has progressed farther in Japan; it has been possible to rest upon the experience of earlier Japanese efforts, and also to adopt much from the Japanese system of nomenclature. Chemical science in Japan was introduced largely *via* Germany with the result that the Japanese

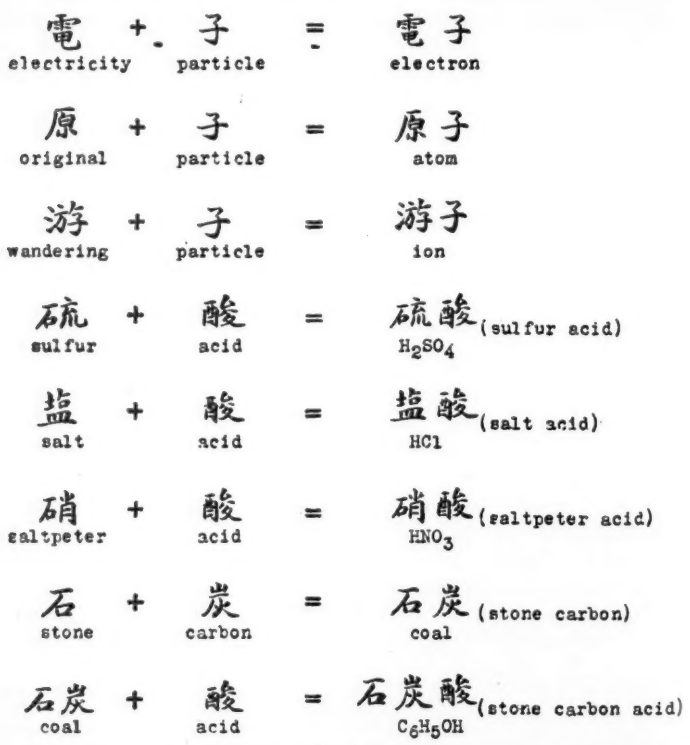
電 + 子 = 電子
electricity particle electron
原 + 子 = 原子
original particle atom
游 + 子 = 游子
wandering particle ion
硫 + 酸 = 硫酸 (sulfur acid)
sulfur acid H_2SO_4
塩 + 酸 = 塩酸 (salt acid)
salt acid HCl
硝 + 酸 = 硝酸 (saltpeter acid)
saltpeter acid HNO_3
石 + 炭 = 石炭 (stone carbon)
stone carbon coal
石炭 + 酸 = 石炭酸 (stone carbon acid)
coal acid C_6H_5OH

FIG. 2.—Typical examples of new character combinations in Chinese chemical nomenclature.

system of chemical terms closely follows the structure of the German. Na_2SO_4 becomes *sulfur acid sodium* instead of sodium sulfate. A similar phrase order is carried through in many instances from German into Japanese and thence into the Chinese.

Some of the Chinese names of the elements are illustrated in Fig. 1. In working out the ideograms a certain system was followed which already existed in the names for those elements which were pre-historic in China.

Oxygen acids of varying valence:

Key words: 過 excess　正 orthodox　亞 inferior　次 very inferior

過氯酸 $HClO_4$ (per-)　正氯酸 $HClO_3$ (-ic)　亞氯酸 $HClO_2$ (-ous)　次氯酸 HClO (hypo-)

Organic terminology:

Key words: 烷 complete (-ane)　烯 lacking (-ene)　炔 very deficient (-ine)

Numerals: 一 one　二 two　三 three　四 four　五 five

一炭烷 methane (one carbon saturated)　四炭烷 butane (four carbons saturated)

二炭烯 ethene (two carbons unsaturated)

二烷五炭烷 ethyl pentane (two saturated five carbons saturated)

Group classifiers: 苯 benzene　因 furane group　醇 alcohol

二烷醇 ethyl alcohol　苯酸 benzoic acid　一烷苯 toluene

FIG. 3.—Additional examples of Chinese chemical nomenclature.

The name for gold has always been generic for *metal*, and, according to the method of the Chinese picture writing, it is combined with other picture radicals to give names for other metals. The radical for stone has in the same way signified a *metalloid*. The character for water implies a *liquid*, that for air a *gas*, and in this way combinations for the simple names of the elements have been built up. The accompanying figures

of typical Chinese chemical picture-grams make no attempt to indicate the sounds. These characters are not for the most part phonetic; each character is mono-syllabic; the sound which any particular word may chance to possess is largely a matter of memory.

Chemistry No. 5.

Experiment 32 B.

Colorimetric Determination of Hydrogen Ion Concentration.

藉色量法以定氫游子之濃度

參考： Chapin, Second Year Chemistry, chap. xv.

作法 本實驗作法與 Exp. 32 略同、係用已知氫游子濃度之溶液、測定下列溶液之氫游子濃度、比較時所用之試管、務須與盛標準溶液之試管相同、否則發生困難、每一試管中只盛所試之溶液 10 cc. 及標示劑五滴、實驗時所用之試管及滴管、於臨用之前、務須查明其確屬潔淨、而後取用、所試之溶液列下、

a. 0·1 N. 醋酸鈉

b. 0·1 N. 醋酸

c. 0·1 M. 酸式炭酸鈉

d. 0·5 M. 硼酸

按 pH 名稱及 $[H^+]$ 名稱述明汝所試驗氫游子濃度之值、

300. 10. 26.

FIG. 4.—Page from a modern laboratory manual in Chinese.

Figs. 2 and 3 illustrate the manner in which old existing words have been put to new uses. The word for *acid* is the old character meaning *sour*. The principle for distinguishing the valences in acids applies also to oxides and other compounds. The very richness of the Chinese

普通無機實驗化學

實驗第三十七

Hydrolysis of Salts.

鹽之水解

參考 近世無機化學 Pp. 293－295.

引論 電解物溶解於水後、卽必速分爲游子、而達其應得之平衡、然須知水之自身、亦係分解游子者、特其濃度殊小、平常多不計及耳、但其濃度雖小、倘有一物溶於其內、則溶液中固已含有四種游子矣、而此四種游子、自必各隨其性、以達其彼此之平衡、如果酸與鹽基、强弱懸殊、而溶液之性情、卽不顯中和、固意中事也、

材料 硫酸鈉、炭酸鈉、氯化鐵、氯化銨、硫化銨、炭酸銨、氯氨化鈣、

作法 (a) 取硫化鈉 (Na_2S) 晶體一粒、以水溶之、試以石蕊紙、並注意其有無氣味發生? (1) 書平衡方程式、以示所遇之反應、

(b) 仿前試炭酸鈉 (Na_2CO_3)、並書其平衡式、

(c) 再試氯化高鐵 ($FeCl_3$)、並書其式、

(d) 末試氯化銨 (NH_4Cl)、並書其式、

(2) 按以上之實驗、凡顯水解作用者、均係何等之鹽? (其酸與鹽基之强度同否?)

乃浸藍石蕊紙於氯化銨 (NH_4Cl) 液中、後懸水蒸汽內熱之數分鐘、(3) 可証溫度與水解有何關係?

(e) 以水 2 cc. 溶氯化銨 (NH_4Cl) 兩克許於試管中、微行加熱、卽嗅其味、或以玻棒蘸內思萊氏試藥 (Nessler's reagent) 懸其中試之、卽以方程示汝結果、

(f) 微嗅新備之硫化銨 ($(NH_4)_2S$、(4) 可書方程、以示其結果、

FIG. 5.—Page from a Chinese laboratory manual of chemistry; note that the chemical formulae are written in Latin letters as in English.

language and its large number of roots has facilitated the fixing of many of the newer terms like *ion*, *electron*, etc. In the organic nomenclature (Fig. 3), the fundamental principles of the Geneva system have been followed. Many of the characters are also suggestive of the molecular constitution. This is true, for example, of the name for *benzene*. The organic terminology has to a lesser degree met the test of class-room teaching experience, and in the light of future use will be subjected to amendment and extension. Complete lists of the Chinese chemical terms are to be obtained in the terminology reports issued by the *Commercial Press* at Shanghai.

The effectiveness of the new Chinese scientific vocabulary rests in the fact that it has met the test of class-room teaching experience. Its successful use has overthrown the superstition that the Chinese language was not adapted to scientific work. The existence of a usable chemical terminology has been accompanied moreover by an increase in the number of textbooks and in the amount of literature available to the chemistry student in Chinese. The impression that the Chinese language is a vague picture writing that cannot be adapted to the requirements of modern scientific thought and science teaching has been exaggerated. In a country with a well-ripened and mellow background of literature and thought, it is essential that a new vocabulary of scientific terms should be thoroughly indigenous. This again is enabling China to regain a position in the realm of chemistry nearer to the point of leadership which she held one or two thousand years ago. And it will enable her to bring to bear on problems of modern scientific advance the thoroughness and the depth of thought which are among her contributions to world effort.

Calls for New Method in Physiological Study. "The proper study of mankind is man;" and this holds for his inner physiology as well as for his mental and social activities. So claimed Dr. C. G. Douglas of St. John's College, Oxford, speaking before the Physiology Section of the British Association for the Advancement of Science.

Experiments on animals are all very well for rough comparative results, Dr. Douglas said, but when we want to find out how the human machinery really works we have to make our observations on a man. This does not involve punching holes in him or sawing him up; it is the physiology of whole, normal, active human beings we are principally interested in, and this can be studied without pain or inconvenience to persons who volunteer for the work.

Good beginnings have been made in the study of human physiology, Dr. Douglas stated, especially in the field of oxygen requirement and other aspects of respiration. Food and its assimilation furnish an equally promising field, but one that has been less explored. Still other possibilities may be found in the chemistry of the blood and in the action of the nervous system.—*Science Service*

STUDENTS' RESEARCH WORK IN HIGH-SCHOOL CHEMISTRY

HATTIE D. F. HAUB, ROOSEVELT HIGH SCHOOL, OAKLAND, CALIFORNIA

The author proceeds upon two assumptions which are universally accepted—at least in theory. These are that the student should be incited to self-activity, and that the course should be organized in such manner that each student may progress at a rate approaching the limit set by his individual capacities. Ways and means of carrying these estimable principles into actual practice are not always obvious—particularly to the inexperienced teacher.

Miss Haub describes in some detail a system of student projects with which she has had marked success. Numerous illustrations of student work are included and an extensive bibliography is appended.

Worth of Special Topics

Dr. G. Stanley Hall once said, "Whether other people really teach anything is a question, but they do sometimes give us impulses and make us find out for ourselves." This statement expresses in a terse way the real value of including individual topics in a high-school chemistry course. In almost every phase of every kind of high-school work, the teacher has planned more or less definitely for the student. But if the special topic is developed as illustrated in the pages which follow, the student makes his own choice, sets his own objective, does his own planning, works generally to his maximum capacity, and regards the teacher not as a taskmaster but as a fellow-worker. He realizes then for the first time that what he knows in an indefinite fashion does not count for much. He needs definite knowledge and the ability to apply that knowledge if he wants results. He does research work suited to his mentality. The individual with the low intelligence quotient is not a hindrance to the brighter student. Even he can shine, as he will be better informed on some one topic than his classmates, and can give an oral report and answer class questions with quite a degree of superiority. That one fact alone makes the use of special topics well worthwhile.

Choice of Special Topics

The choice of the subject for his research should be made definitely at the beginning of the second term of the year of chemistry. By that time the student has acquired what may be termed "a set of chemical tools," which enables him to proceed with individual reading and experiments. If a preceding class has done this work, many students who have seen it enter the beginning chemistry class with at least a general idea of what they want to investigate, though a few students always need much help in making their choices. Several weeks before the end of

the first term the teacher should present to the class a list of projects, briefly outline their value in life, and show what can be done with them by high-school students. The list should have more topics than there are members of the class. There is no reason why more than one student should not be allowed to make the same choice, nor is there any reason for limiting the choice of a subject to those suggested by the teacher. After this preliminary talk, the students should be encouraged to think about their probable topic for investigation, and to discuss it at home, with the teacher and with other pupils.

When the first decision is made, the student should hand in the name of the topic he wants and why he wants it. He may not know the specific title then and will probably change it later. Very often the young investigator chooses too big a field for his limited time and ability and later finds he must narrow it considerably. For example, the boy who chooses explosives may find that he wants to work especially with gun cotton or picric acid. Gun-powder is not thrilling enough. Therefore, his original title must be changed. Often a student finds that his early enthusiasm for a subject wanes as he investigates it, and other things appear more alluring. Within limits, the switching from one subject to another should be allowed.

Reasons for Choice

There are many factors which determine the choice of the topic. Many times the interest awakened by a father's or relative's business is the dominant motive for the student's decision. Often the interest is aroused by the work done by the student out of school, or by the work or profession he intends to follow later.

Sometimes a discussion starting in other classes stimulates interest in the chemical side of the problem and leads to the choice of such topics as "The Potash Supply," "Industrial Poisons," "Phosphorus Matches," "War Gases," "Explosives." Very often the student has no other reason for his choice than that it just appeals to him, or that he wants to know something about it, or that it sounds easy or familiar. Such topics as "Ink," "Paper," "Soap," "Tooth Powders," "Baking-Powders," etc., are often selected because of this.

Preliminary Work

After the second term begins the student should be asked every Monday in class to write in a few sentences what he has done on his topic the preceding week. Everyone occasionally has the feeling best described by the Spanish *mañana*, but some students have it continually and to a marked degree. This scheme acts to some extent as a preventive, as no student cares to hand in more than once a paper saying, "I did no work last

week on my special topic." Then, too, the knowledge that other students are doing interesting things spurs on the sluggards of the class. The teacher need make no comment but simply read aloud such statements from students' papers as, "I think I have secured permission to visit a hospital to watch the effect of an anesthetic on a patient;" "I have written my first chapter telling the early history of photography;" "I have made out my outline, and planned to write at least four pages a week;" "I have received an answer to my letter and some splendid material from a match company;" "My father has made arrangements for me to visit the Standard Oil Factory as soon as I have done more reading." "I did some reading in the bacteriology you loaned me, but there is so much I didn't understand; I am coming to you for help."

Experimental Work on the Special Topic

The class chooses a week which shall be theirs to devote to their own experimental work. Arrangements should be made to have this class use the laboratory exclusively for the week, so that an experiment may be set up Monday and worked on until Friday, if the student desires. The janitors should be instructed to keep away from all material, no matter how messy it may seem. If only one teacher uses the laboratory such arrangements can be made easily; if more than one person uses the laboratory, some good-natured adjustment must be made.

Several days before this experimental week the teacher needs to have individual conferences with the pupils to see that the necessary chemicals are in stock, and that no experiment is undertaken which involves danger to the student or his classmates. Moreover, he should see that at least a part of the experiments to be done are apt to come out successfully. Not all high-school students are made of the same stuff as was young Perkin, who spent two years in an unsuccessful endeavor to isolate phenanthrene from coal tar and to prepare artificial quinine. The majority of our young chemists need the stimulation that comes from positive results.

The week of experiments is a busy but a happy one for the teacher. He will be called upon to come early, stay late, and be available at lunch hour. If he objects to saying "I don't know," he had better not attempt this work. He will be asked more questions and find he knows less about chemistry than at any other time in his career. But the enthusiasm and resourcefulness of the students is remarkable, and the teacher in the end is well repaid for the extra work. Many of the more enthusiastic students will want to work extra time on their topics.

Form of Paper

A definite date must be set for calling in the papers, and a definite form for the written account of the work accomplished must be demanded.

Each paper should have a cover for protection, a title page, a bibliography, a table of contents, and the written account of the work. The cover may be plain or decorated in some fashion. No credit is given for a fancy cover, but nearly all students prefer to have one. It must be made clear to them that this paper is a dignified affair and is cheapened by silly illustrations. Occasionally a student displays a real sense of humor in illustrating the cover as was shown by one who wrote on "Patent Medicines," and had on her cover, a goose with its mouth wide open. The title page should contain the name of the topic, the student's name,

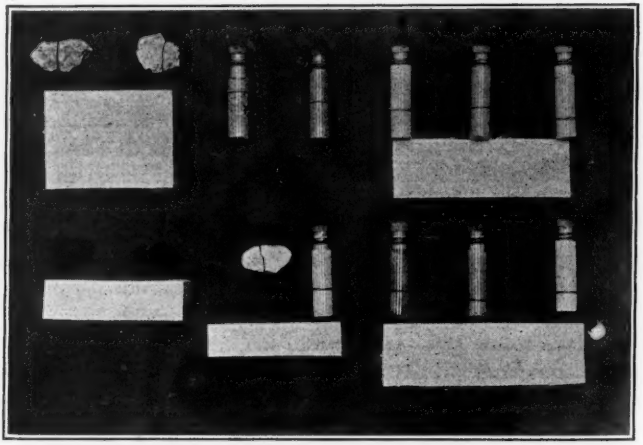

FIG. 1.—PORTLAND CEMENT

Samples obtained from factory

1, Lime rock containing 65% $CaCO_3$; 2, Lime rock containing 40–50% $CaCO_3$; 3, Clay; 4, Sand; 5, Mixture of 1 and 2; 6, Mixture of 3 and 4 (one part sand to two parts clay); 7, Mixture of 6 and 5 (finely ground); 8, Partly fused 7; 9, Completely fused 7—clinker; 10, Calcium sulfate (lump and pulverized); 11, Mixture of 9 and 10; 12, Finely pulverized 11 (finished cement, colored); 13, cement, white, made from sand free of iron impurities.

and the date. The bibliography should contain the name of author, title, publishing company, and date of publication of each book used. The books should be arranged alphabetically according to authors, or chronologically according to dates of publication. Magazines should be listed separately. The author, if known, the title of the article used, the name of the magazine, its volume number, and the date of publication should be given.

The student must learn that he needs recent books for present-day chemistry, as industries dealing with every branch of this science have made gigantic strides within the last few years. If the student gets his information about storage batteries from a book printed ten years

ago he will find he lacks much knowledge about the batteries now in use. The table of contents should be what its name implies, and the

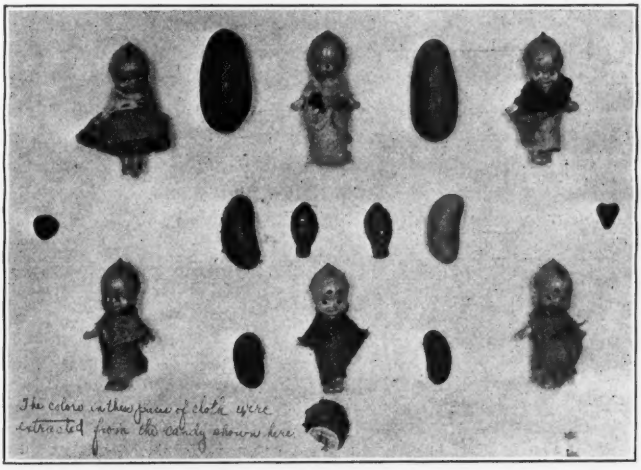

FIG. 2.—COLORS IN CANDY

The dyes were dissolved in water by allowing the candy to soak for a few minutes. Small pieces of white woolen yarn and white woolen cloth were boiled in the solution, dried and then made into dresses for the dolls.

student should make that before, instead of after, writing his paper. The paper itself should contain something about the early history of the subject, if the student desires to include it, a concise and definite account of the present-day industry, and a clear, detailed account of the student's

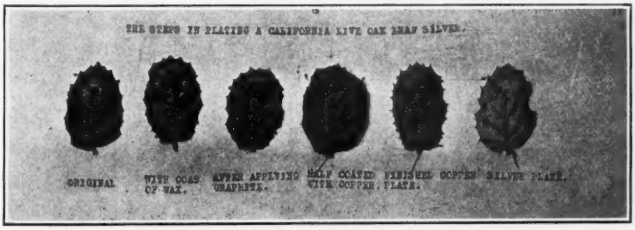

FIG. 3.—ELECTROPLATING

own experiments, and of his visits to factories or exhibits. Copies of his letters to manufacturers and their replies to him should be included in the book.

Coöperation with Other Departments

In many schools the English department is willing to accept these papers as English themes. The typing department will often type them for the students, and the drawing department will illustrate them. In some schools the librarian may be willing to help with the actual book construction, and the printing department shows students how to bind the books. If help is received in any way, the pupil must be taught that the square and courteous thing is to acknowledge such help in a preface in his book. Many students wish to dedicate their books, and it is both surprising and encouraging to note the number of boys who dedicate the books to their mothers. The length of the paper would best be left

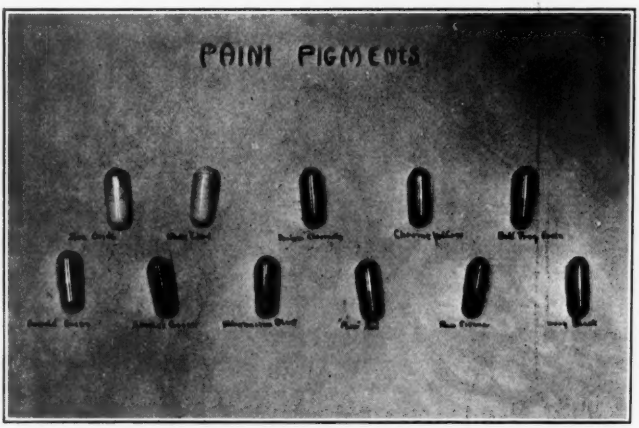

FIG. 4.—PIGMENTS
Pigments made in laboratory and mounted in gelatin capsules.

to the student himself. He should be asked to use discretion, however, as a teacher has to correct it later. If illustrations are used, much descriptive writing can be eliminated.

Mounted Samples

Each paper should be accompanied by a mounted set of samples, obtained preferably from his own work. If not able to procure these, specimens obtained from factories should be mounted. (See Figs. 1 to 7.)

Oral Reports

Sometime during the term the student should be required to give a twenty-minute talk to the rest of the class. He may follow his paper, or give an entirely different talk as he sees fit. In either case it should

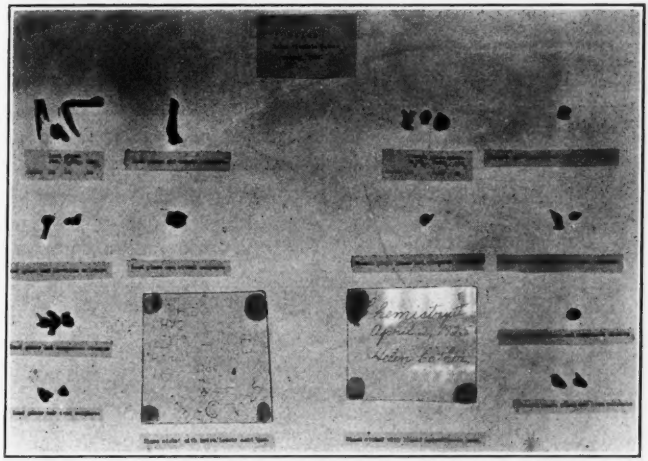

FIG. 5.—GLASS

The materials, PbO (24), K_2CO_3 (14), and SiO_2 (38) parts by weight, for lead glass, and Na_2CO_3 (17), $CaCO_3$ (7.25), and SiO_2 (50) parts by weight for plate glass, were fused in an electric furnace made of a hollowed-out fire brick. Two carbon electrodes were used, the current being 220 v. A resistance coil from an electric heater was put in the circuit. Insulating was done with strips torn from an old rubber apron. Each kind of glass was colored with cobalt chloride, chromium sulfate, nickel sulfate, manganese dioxide, and iron sulfate.

Ordinary window glass was etched, (1) with hydrofluoric acid gas, made in a lead dish by the reaction of sulfuric acid and calcium fluoride, and (2) with commercial hydrofluoric acid.

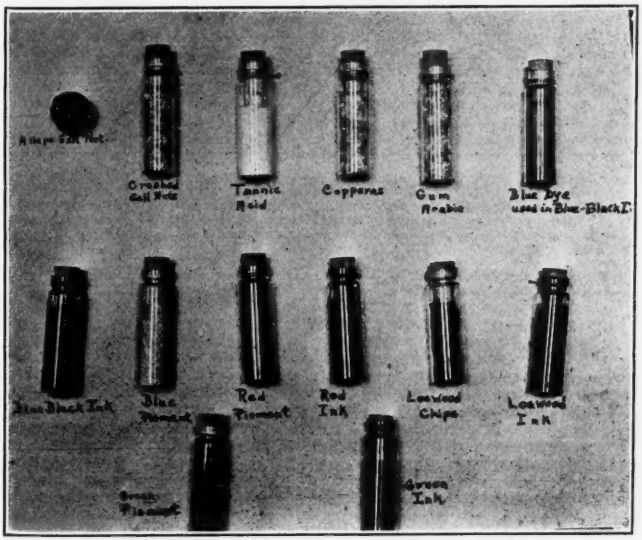

FIG. 6.—INK

be well organized and his outline should be put on the board before he begins to speak. If he is asked to put on the board five pertinent questions which the class should be able to answer in the light of his exposition, the young lecturer finds that he must present his subject in a clear and definite fashion. He shows his illustrations, and oftentimes has special material for his talk. One boy obtained the display put out by an Edison Company, the company packing, shipping, and paying the express charges on the exhibit.

Parents often become interested in the work and accompany the

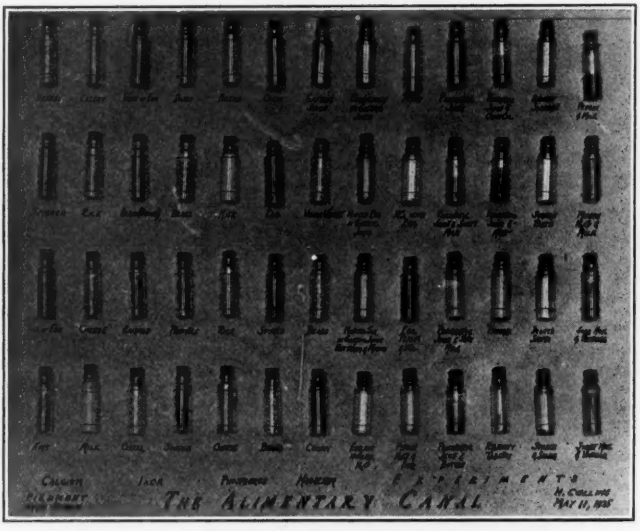

FIG. 7.—THE CHEMISTRY OF DIGESTION

Foods rich in calcium, iron, phosphorus, and magnesium are mounted in the bottles in the first seven rows. The other bottles contain the results of experiments with gastric and pancreatic juices on eggs, milk, and meat; with rennet on milk and with saliva on starch.

children to factories or help them at home with experiments. One mother baked biscuits with the baking powder made by her son and then wrote him a testimonial saying his powder was equal to any she had ever used, and superior to some of them. This testimonial was shown to the class with great pleasure.

Sugar as a Special Topic

A few concrete illustrations will serve to show definitely how the special topic work is carried on. One boy desired to learn all he could about beet sugar. He wrote to several sugar factories, read articles in books and current magazines, and finally decided he wanted to get some sugar

from the beet. From one of the sugar-beet factories he obtained some sugar beets, sliced them, soaked them in water, strained off the sweetened water, treated the solution with calcium hydroxide and carbon dioxide to precipitate impurities, and with sulfur dioxide to prevent any fermentation. He filtered off the precipitate, and evaporated the filtrate on a water-bath. The molasses was freed from the sugar by placing the mixture in flat-bottomed vials, and whirling them in a Babcock separator. During the spring vacation week he spent his entire time at the sugar

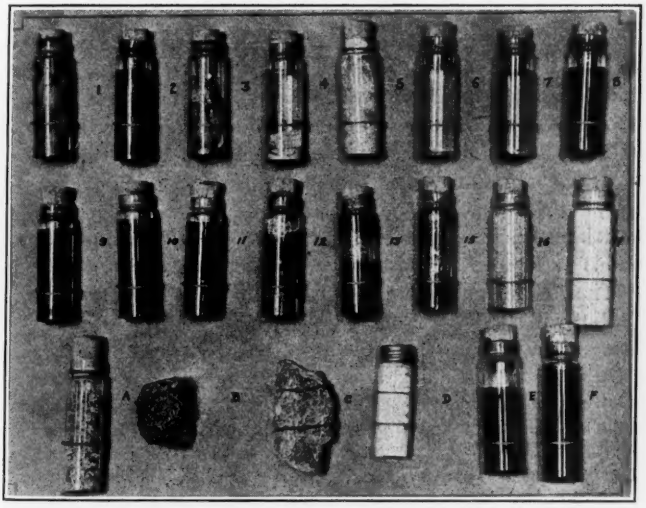

FIG. 8.—SUGAR SAMPLES OBTAINED FROM FACTORY

1, Cosettes, pieces of sliced beet in water; 2, Impurities precipitated by lime; 3, Beet residue; 4, Impurities; 5, Impurities dried; 6 to 15, Sirup, increasing sugar content due to evaporation of water; 16, Raw sugar; 17, Refined sugar; A, Beet seed; B, Coke; C, Limestone; D, Lime; E and F, Molasses.

factory, where he did everything from cleaning the beets to reading the polariscope.

In writing his paper he dealt, first, with the question of the world's sugar supply, and then with the development of the beet-sugar industry and of its struggle for existence in competing with the older and well-established cane-sugar industry. Next he discussed the chemistry of the beet plant, then methods of extracting the sugar from it, the chemistry of some of the saccharides formed in precipitating the impurities, and ended with an account of his own work. His written work was freely illustrated with pictures cut from magazines as well as with his own drawings. To accompany the paper he prepared a carefully mounted

set of specimens, showing the sugar beet seed, the sliced beet, the precipitated impurities, the sirup in increasing degrees of concentration, the sugar, and molasses. Since this factory made its own lime, he completed his chart by adding samples of coke, limestone, and lime. (See Fig. 8.)

One of the girls who later took the same topic, knew what she wanted before she entered the chemistry class and planted her seeds soon enough so that she could get sugar from her own beets.

Paper as a Special Topic

As another illustration, the work done by a student choosing paper as a topic will be described. He discussed the early history of paper, then the occurrence and properties of cellulose, and then the present-day process of making paper from rags and from wood, both by hand and by machine. His own experiments consisted of testing stationery, high-class magazine paper, and newspaper for wood pulp, animal size, rosin size, and starch. He tried to size some unsized paper with gelatin, and to make parchment paper with sulfuric acid. The most ambitious part of his experimental work was making paper from rags, and from wood. The following account is as he wrote it. One may question the English, but will surely approve of the spirit.

PAPER FROM RAGS

I used many make-shifts in making paper from rags, but had fair success in the end. I did all this work at home so I had to get along mostly with kitchen utensils.

First some rags were cut up. Then they were boiled for about 5 hrs. in lye. Then the rags were thoroughly washed, and put back in a saucepan. There was a can labeled "chloride of lime" in the laundry, so I thought maybe it might bleach, and chucked some in. The mass was kept warm for about an hour and sure enough, it bleached. A sizzling noise was heard, and, on investigation, a hole was found in the saucepan. (It was an enameled iron one, and was chipped in several places.)

Then began the worst of it all, the beating. A large chocolate can was found, and a potato masher made a fine beater. I tried the egg-beater, but it didn't work. The rags and some water were put in the can, and were beaten in all my spare time for a week or so. Every now and then the pulp was put in a collander, and all that would go through the holes was half-stuff, to be saved and beaten some more later.

After long pulping and straining, a fairly good grade of stock was obtained. Next a method of forming a sheet had to be devised, so the hand-made method was followed as closely as possible.

Luck was with me here, for I found some wire cloth of $^1/_{100}$ inch mesh, and made a screen, about 4″ by 6″ by tacking the wire onto a little wooden frame. The pulp was poured on this, the water allowed to drain off, and the web put on a piece of flannel, the nearest thing to felt I could find.

We had an old paper-press, a heavy affair where an iron plate was screwed down against the base plate with a wheel. This was my hydraulic press, and worked fine. After removing the sheet from the press it was pressed and "plated glazed" with mother's hot flat-iron. All my paper was made that way, and the ink ran.

Loading and Sizing

After obtaining the necessary chemicals from school, I proceeded to make the rosin size. I loaded with china clay, and sized with rosin size, just as it is done commercially, and made a piece of sized paper. The ink does not run, but the surface is too soft.

To another piece of paper ultramarine (washing bluing that I found around the place) was added. I had some pastel crayons home, so I ground up some yellow and purple and colored two other pieces.

One piece of paper is the big success. It is animal sized. A piece of paper was made with loading and coloring, but no sizing. It was then animal sized as already described in the beginning of this chapter, and stuck to the hot iron as already described.[1] After burning up one piece, this was made. It had a hard surface, is strong, and is ink-resisting. Incidentally, it is the hardest to make.

Paper from Wood

Thinking it would be interesting to try to get paper from wood, which is harder than from rags, I tried it. In one way it was more successful than that made from rags, in another way, less.

Luck again favored me. Poplar wood is the best wood known to make paper from, and the people next door had just cut down a poplar tree, I stole a log of it, and shaved it up with a plane.

Using the Soda process, the wood was boiled with sodium hydroxide for 12 hours.

Reading that in 1000 A.D. an iron pestle and mortar were used to make pulp I thought I would try it, and beat the shavings for about 3 hours in the mortar. It worked splendidly, defibering the stock much more completely than when the rags were beaten.

Then came the unsuccessful part of the work, the bleaching. The material bleached a little, but stayed yellow. This was partly due to the iron and iron rust from the mortar, partly to imperfect digestion.

I left it in a solution of bleaching powder over-night, but it wouldn't bleach. A sheet of unsized paper was formed in the same way as previously, and the surprising part about it was that the ink hardly spread at all. This was probably because the pestle had absolutely no cutting action where the masher did. The individual fibers were uninjured, cutting down the absorbent power.

In another sample ultramarine was added to neutralize the yellow and succeeded to a slight extent.

Then came the hair-raising stunt of animal sizing, with the usual close calls. The product looked as if it had seen a tough time. It put a fine surface on the paper, strengthened it, although the unsized paper was unusually strong. It darkened the color, however.

In the conclusion I want to say that I have learned a great deal from my special topic, and have had a lot of fun, even if it did embody a good deal of time and work. (See Fig. 9.)

Another boy made paper in a somewhat similar manner. Lacking a paper press he placed his wet pulp on felt cut from an old hat, between two smooth boards. The boards were then left over night between the jack and the rear axle of the family automobile. Needless to say, the water was fairly well pressed from the pulp by morning.

[1] This refers to a portion of his account not reproduced.

Visits to Industrial Plants

Occasionally it is wise to plan a class trip to an industrial plant. There are sometimes many obstacles in the way of this. The laboratory period is too short to make a profitable visit and it is not always fair to take students from other classes even for important science work. The adjustment depends on the coöperation between teachers in any given school, and the number of outside calls made on regular class time. The

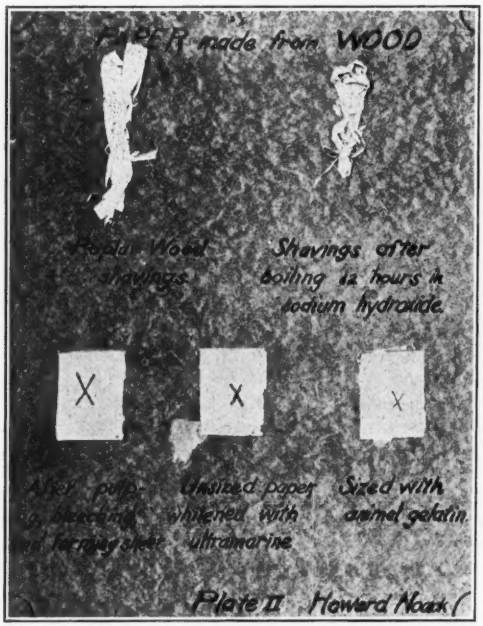

FIG. 9.—PAPER

Poplar wood shavings were boiled in sodium hydroxide solution, beaten in an iron mortar with a pestle, bleached and made into paper.

period between the closing of school and the closing of the plant is generally very short, and Saturday morning visits are not appreciated by many factories. The students should arrive at and leave the plant in a body, which means that transportation facilities must be arranged.

Even if these obstacles are successfully met, the trip itself will be of doubtful value unless it is carefully planned. The teacher should have visited the plant first and decided what is of particular value for his class. He might make a list of questions which he will expect the stu-

dent to answer after an inspection of the manufacturing process. If the student realizes that he is to obtain definite knowledge he is more apt to stay with the crowd and get within hearing distance of the guide's explanation. It should be remembered that the best-intentioned guide is not a teacher and the class must be given help before the visit is made. A vacuum pan is not a pan, nor is an open-hearth furnace open. Sometimes the last of a process is shown first to avoid going up and down stairs too often. Wild mental confusion may result if the student does not understand this. It depends on the teacher whether or not the economic side of the industry is considered. The environment of the employees, their salaries and chances for promotion, the skill demanded for their work, etc., are usually of great interest to the student.

The trips that have given best results are those made by small groups of students to factories in which they are vitally interested. Permission is obtained through members of the Chamber of Commerce, through friends or parents, or through the efforts of the students themselves. Many concerns are more than gracious in coöperating with schools. Frequently the student has so interested the family in his special topic that the family automobile takes him to, and the family head accompanies him on his sight-seeing tour of the chosen factory. In this case the student needs but little help from the teacher, as he is seeking specific bits of information, and he will make opportunity to ask unlimited questions of his guide.

References for Special Topics

Advertisements seen in the current magazines are a wonderful help in starting a student on his search for first-hand information. Letters written to the various firms usually bring literature advertising the product in question but along with it some valuable material discussing the process of manufacture. Some firms send letters containing a really worthwhile bibliography, and some send samples of their products free of charge. Other firms have displays which they are willing to furnish to schools if the teacher will write for them. Sometimes there is a small charge barely sufficient to pay for the postage.

Sources of information can be obtained from the Secretary of the American Chemical Society, Washington, D. C. Pamphlets on research work carried on by the government can be obtained from the Superintendent of Documents, Washington, D. C. These are sometimes free and sometimes cost from five cents up; few of them are more than twenty-five cents.

The following list contains the titles of some of the special topics and the authors of books used by students and obtained by them from city, university, or school libraries. The detailed titles may be found in the bibliography given at the end of this article.

Special Topics

Alchemy—Clarke, Edmunds and Hoblyn, Moore, Muir, Sadtler, Smith, Waite, Williams.
Atoms—Caldwell and Slosson, Comstock and Troland, Gordon, Lewis, Martin, Mills, Millikan, Soddy, Venable.

Bacteria—Buchanan, Caldwell and Slosson, Conn, Jewett, Jordan, Muir and Ritchie, Olsen, Prudden, Sedgwick, Vallery-Radot.
Beverages—Leach, Olsen, Vulte and Vanderbilt, Woodman, Wiley.
Bleaching—Clarke, Gray, Snell, Thorp.

Ceramics—Benson, Bourry, Cox, Duncan, Findlay, Lassar-Cohn, Reis and Leighton, Rogers.
Cement—Benson, Desch, Eckel, Meade, Sabin, Rogers.
Cellulose—Bailey, Benson, Hendrick, Howe, Lassar-Cohn, Slosson, Tilden, Wooden, Woolman and McGowan.
Chewing Gum—Pamphlets from the American Chicle Co., Wm. Wrigley, Jr. Co., Beech-Nut Co., etc.
Coal Tar—Caldwell and Slosson, Cain, Fuller, Hall, Howe, Matthews, Pellew, Slosson, Tilden.
Corn Products—Rogers, Slosson, Thorp, Pamphlets from U. S. Dept. of Agriculture, Corn Products Co., American Manufacturer's Association of Products from Corn, etc.
Cosmetics—Askinson, Holler, Wiley.

Dentifrices—Wiley, Pamphlets from tooth powder and tooth paste houses.
Digestion—Lassar-Cohn, Lusk, Olsen, Rose, Sherman, Styles, Tilden.
Dyes—Hendrick, Mathews, Moore, Pellew, Rogers, Tilden.

Electric Cells—Clarke, Comstock and Troland, Howe, Soddy, Talbot and Blanchard, Thompson, Timbie, Wade, Willoughby.
Explosives, Fireworks, Etc.—Barnett, Bird, Clarke, Lefebure, Marshall, Martin, Philip, Rogers, Slosson, Tilden, Thorp, Weaver, Wooden.

Fertilizers—Clarke, Duncan, Howe, Rogers, Sadtler, Slosson, Pamphlets from the Department of Agriculture.
Fire Extinguishers—Crosby, Dana, Literature from the Foamite Firefoam Co. and the Pyrene Manufacturing Co.
Flavorings—Clarke, Howe, Leach, Olsen.
Food Adulterations—Blyth, Leach, Olsen, Woodman and Norton, Woodman, Slosson.

Gasoline—Caldwell and Slosson, Cressy, Ellis and Page.
Glass—Duncan, Gerard, Howe, Rogers, Rosenhain, Sadtler, Thorp, Yerk.

"Hop"—Kellog, Towns.

Illuminating Gas—Bird, Cressy, Findlay, Lunge, Norman, Rogers.
Ink—Davis, Mitchell, Circular No. 95 (Supt. of Documents, Washington, D. C.).

Oils—Hamor and Padgett, Hendrick, Lewkowitsch, Rogers.

Paints—Rogers, Thorp.
Perfumes—Askinson, Bird, Duncan, Hendrick, Howe, Martin, Parry, Rogers, Tilden.
Petroleum—Day, Hamor, Lidgett, Pell, Rogers, Ross, Thorp, Tilden, Tower.
Photography—Clarke, Derr, French, Howe, Johnson, Roebuck, Sadtler, Story, Watkins, Eastman Kodak Co.

Precious, Imitation, and Artificial Stones—Goodchild, King, Kunz, Martin, Pavitt, Philip, Rothschild, Thorpe, Wade, Wodiska, Mastin, Clarke.

Patent Medicines—American Medical Association Pamphlets, Hodgdon, Nelson, Street.

Road Construction—Baskerville.

Rubber—Benson, Howe, Rogers, Simmons, Sadtler, Slosson, Thorp, Tilden.

Soap—Brannt, Clarke, Diete, Hendrick, Hurst, Rogers, Sadtler, Slosson, Thomassen, Thorpe, Literature from Soap Factories as Procter & Gamble, Palmolive Soap Co., etc.

Stains—Owen, Snell, Thorp, Department of Agriculture, Bull. 861.

Steel—Bird, Gulliver, Slosson, Spring.

Sugar—Brewster, Leach, Lusk, Hendrick, Martin, Moore, Rogers, Rolph, Sadtler, Sherman, Slosson, Taylor, Tilden.

Textiles—Dooley, Duncan, Dyer, Gibbs, Howe, Rogers, Sadtler, Snell, Slosson, Woolman and McGowan.

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Dyes and Colloids Found Most Effective Germicides. The search to find the perfect disinfectant was described by Dr. Herbert C. Hamilton, research chemist for a large pharmaceutical firm, to members of the American Chemical Society.

The weakness inherent in most chemical germicides lies in the fact, he explained, that the ones that kill germs effectively also injure the surrounding body tissue. Exceptions to this general rule are the class of chemicals known as colloids, of which argyrol is an example, and certain of the aniline dyes which seem to have a selective action.

This condition does not necessarily imply, said Dr. Hamilton, that the germicide is selective in the sense of attacking the microörganisms in preference to the tissue of the body but, more probably, to specific differences in the resistance of the organisms.—*Science Service*

Two Medicinals Extracted from Pituitary Gland. Two active principles of great potency in their effect upon the human body have been extracted from the pituitary body, Oliver Kamm and associate investigators of Detroit reported to the American Chemical Society at its recent meeting. The pituitary body is a gland about the size of a pea, situated at the base of the brain. It has long been known that the gland secreted certain substances into the blood which had a powerful influence on the rate of bodily growth and the activity of various organs, but since these compounds could not be separated from one another and obtained in pure form their use in medicine was uncertain and restricted. Now, however, two of the compounds from the back lobe of the gland have been isolated and so they can be analyzed in the chemical laboratory. One of them injected into the blood greatly increases the blood pressure and the other causes strong contractions of the uterus.—*Science Service*

Coated Fabrics No Longer Merely "Imitation Leather." Cloth coated with various wear- and weather-resistant materials masqueraded as leather in the early days of the automobile. Now, however, the various coated fabrics have reached a stage of excellence where they can make their own way on their own merit, and "imitation leather" as a term of semi-reproach is no more.

Thus reported Dr. Hamilton Bradshaw of the du Pont laboratories at Wilmington, speaking before his colleagues of the American Chemical Society.

Coated fabrics are of three principal types, Dr. Bradshaw stated. They are coated with preparations of linseed oil, with rubber and with pyroxylin, which is one of the new "plastics" made by dissolving cotton or wood-pulp cellulose in an acid. The linseed oil fabrics belong to the oilcloth class which are little used in motor cars. The rubber preparations are used mainly in top fabrics for both open and closed cars. In the latter class they have wholly replaced the old solid, rattly tops of wood or metal.

Pyroxylin fabrics are almost universally used as upholstery in open cars now, the speaker declared. Over ninety per cent of such cars turned out last year were upholstered in this type of leather replacement. The strange part of it is, that now the coated fabric does not need to imitate leather, it has reached the point where it can fool even an expert. Dr. Bradshaw told of examining a car that was finished partly in real leather and partly in grained coated fabric. Only when the leather and fabric were loosened and their backs examined was he able to tell them apart.—*Science Service*

VISCOSE RAYON

MILTON J. SHOEMAKER, THE CELON COMPANY, MADISON, WISCONSIN

The problems arising in the manufacture of viscose rayon are of a mechanical and chemical nature and may be divided into two groups, viz: those relating to the preparation of the viscose solution, and those pertaining to the "spinning" process by which the rayon filaments are formed. In the present paper Dr. Shoemaker briefly discusses both phases of the manufacture of rayon.

The discovery that wood pulp could be dissolved as sodium cellulose xanthate by treatment of alkali cellulose with carbon disulfide was made in 1892 by Cross, Bevan, and Beadle. This discovery came as a new and great inspiration to the study of cellulose chemistry and to the commercial utilization of the new cellulose ester to produce rayon. Years of intensive research marked by such epochal contributions as those of Stearn and Topham followed. It is to the indefatigable efforts of the chemist and engineer and the unfailing faith of financiers that, even in the face of apparently insuperable obstacles, the rayon industry owes its almost miraculous growth from nothing to a production in the United States of nearly 90,000,000 pounds in 1926.[1]

The preparation of the viscose solution from which rayon is spun involves the mercerization of cellulose, the depolymerization of the cellulose aggregate, esterification called xanthation, and the solution or dispersion of the xanthate in water.

The cellulose base consists of bleached spruce sulfite pulp or cotton linters, and reaches the rayon plant in the form of sheets somewhat similar to blotting paper. The chief characteristics of the pulp are high alpha cellulose content and uniformity as regards viscosity, composition, and moisture. Resins and ash are at a minimum. Since the yield of rayon is proportional to the alpha cellulose content and to a lesser extent to the beta cellulose content it is important that the first at least be high.

The mercerization of the pulp is carried out by immersing the pulp sheets in a solution of 15%[2] to 18.6%[3] caustic soda in the trough of a press.[4] Unless the pulp is very low in beta and gamma cellulose it becomes necessary to curtail the amount of hemi-cellulose in the steeping or mercerizing liquor. Naturally this is easiest accomplished by throwing away a substantial portion of the liquor after steeping. The result is a tremendous loss of caustic soda which probably amounts to a million and a half dollars annually. It is encouraging, however, to note that

[1] W. J. Baxter, Editor of *Rayon*, New York.

[2] U. S. Pat. 1,502,101.

[3] H. Eggert, *Kunstoffe* **3**, 381–2.

[4] "Artificial Silk," Arthur Fath, *Chemical Age*, **1923**, p. 246.

at least two interesting methods for the recovery of caustic soda show promise of usefulness. One[5] contemplates the use of copper sulfate to precipitate the hemi-cellulose; the other[6] contemplates the separation by means of dialysis.

The mercerization action takes place about as fast as the caustic soda solution can soak into the pulp, there being little change after the first minute.[7] It is still a mooted question as to whether the alkali cellulose formed in mercerization is a compound or merely an absorption product. Gladstone's[8] work seems to indicate the lower the concentration of caustic soda the less is the percentage uniting with the cellulose. Vieweg[9] and Miller[10] show higher percentages of caustic soda uniting when solutions of about 16 or 32% NaOH are used. Leighton[11] points out that the absorption values of Vieweg and Miller could only be correct if there is no absorption of water by the cellulose. The fact that cellulose absorbs water would, therefore, seem to vitiate their results. The results obtained by Leighton's centrifugal method would certainly seem to indicate that alkali-cellulose may be regarded as an absorption product. Other than the swelling and distortion of the cellulose fibers by the osmotic action of the caustic soda there seems to be no direct change effected by it.

The presence of metallic oxides even in minute amounts in the steep liquor has a catalytic effect upon the subsequent maturing of the alkali cellulose.[12]

The excess of caustic soda is squeezed out of the pulp sheets until the ratio of pulp to alkali cellulose is 3.1[13] to 4.5.[14] To accomplish this a very considerable pressure must be applied by the press or centrifuge.[15]

The chief object of squeezing out the excess caustic soda is to make the alkali cellulose sufficiently dry to allow intimate contact with the carbon-disulfide vapor. After the squeezing operation the alkali cellulose is shredded in a Werner and Pfleiderer machine to produce a light fluffy mass. The latter operation, however, is of secondary importance to the fact that the alkali cellulose must be "ripened" for several days at or near room temperature. It is not known just what happens during this time. The view[16] has been advanced that a depolymerization of the cellulose

[5] German Pat. 252,179, Class 29b, Jan. 19, 1912.
[6] German Pat. 287,092, Class 29b, July 1, 1914.
[7] Hubner and Teltschner, *J. Soc. Chem. Ind.*, **28,** 641 (1909).
[8] *J. Chem. Soc.*, **17,** 5 (1852).
[9] *Ber.*, **40,** 3876–83 (1907).
[10] *Ber.*, **40,** 4903 (1907).
[11] *J. Phys. Chem.*, **1916,** p. 47.
[12] Swiss Pat. 70,744 and 71,681.
[13] "Artificial Silk," A. G. Perl, *J. Tex. Inst.*, **1925,** p. 195.
[14] Cross, Bevan, and Beadle, *J. Chem. Soc.*, **58,** 837 (1893).
[15] "Les Soies Artificielle," Chaplet, **1926,** p. 47.
[16] Eggert, *Loc. cit.*

aggregate occurs and it seems quite probable that this is catalyzed by the caustic soda. The actual effect of aging is to reduce the viscosity of the resulting solution and to increase the beta and gamma cellulose at the expense of alpha cellulose. It remains as a problem for the future to determine whether optimum results are to be obtained by aging a short time at a high temperature or a long time at a lower temperature.

Certainly, higher temperature accelerates the depolymerization and since the reaction is an exothermic one the loose physical condition obtained by shredding makes possible a more rapid dissipation of the evolved

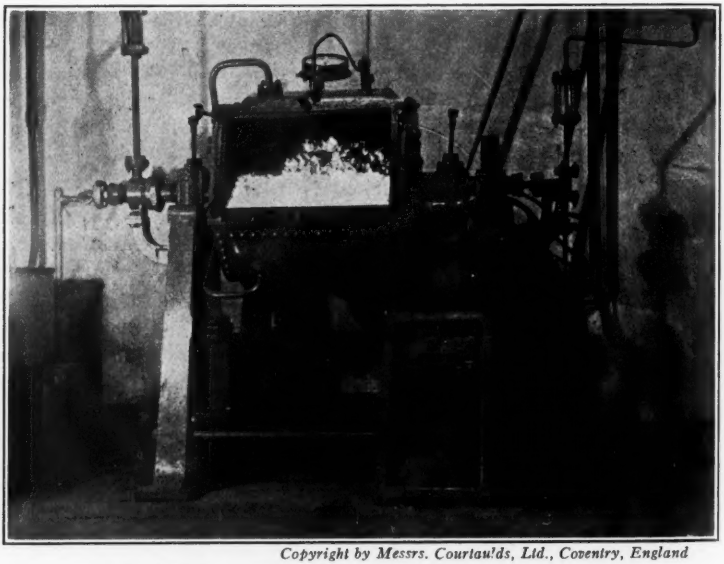

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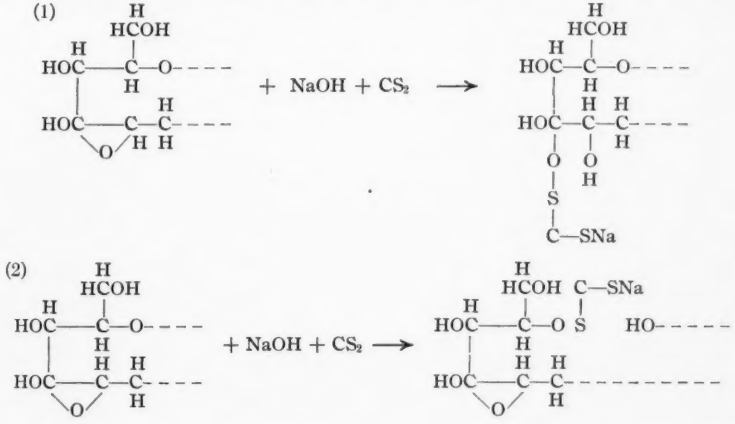
FIG. 1.—TREATING CELLULOSE CRUMBS WITH CARBON DISULFIDE

heat. Hence, the object of shredding is to prevent the reaction from becoming too rapid to be readily controlled. Besides the depolymerization action, oxygen is absorbed if it is available.

The factors discussed up to this point are those which determine very largely the viscosity and hemi-cellulose content of the resulting viscose solution. When the alkali cellulose has been ripened to the desired extent it is xanthated by treatment with carbon disulfide in a rotatable closed container with horizontal axis and which may or may not be jacketed.

Xanthation takes place through the lactone oxygen of the cellulose molecule and, therefore, appears to have the following types of structural possibilities.

If a reaction of the second type occurs it seems quite probable that the viscosity would be reduced since it is apparent that the chain of cellulose groups would be broken. When the reaction is conducted at higher temperatures (25° to 40°C.) there is a very material lowering in the viscosity, and it seems probable that the reaction of the second type occurs. It is common practice to xanthate for from $1^1/_2$ to 3 hours at a temperature of 20° to 35°C. using an amount of carbon disulfide varying from 10 to 20% of the weight of the alkali cellulose. The reaction is exothermic and its degree of completion is proportional to time and temperature. A secondary reaction between the excess caustic soda and carbon disulfide results in the simultaneous formation of sulfides



and thiocarbonates which color the mass at first yellow, then orange, and red.

The xanthated alkali cellulose is dissolved in a dilute solution of caustic soda to form a heavy sirupy liquid called viscose. Ordinarily the concentration of cellulose in the solution varies from 7 to 9%, and the caustic soda about a per cent less. Viscose is a colloidal solution in which the disperse phase is sodium cellulose xanthate and the dispersion medium a dilute solution of caustic soda containing as impurities sodium sulfide and thiocarbonate. Sodium cellulose xanthate is unstable at ordinary temperatures and, therefore, constantly decomposes.

The aging of viscose is characterized by viscosity changes, by the reduction of xanthate or ester sulfur, and by its increasing susceptibility to coagulation by salts, acids, and heat. Higher temperatures accelerate these changes. Viscose solutions of high caustic soda content and of low cellulose content exhibit lower rates of change or reversion to cellulose.

The viscosity of viscose has been shown to drop during the early part

of its aging, reach a minimum,[17] and then increase until gelatinization and syneresis take place. The initial drop in viscosity may be explained if it be assumed that complete peptization of the disperse phase does not occur until the minimum viscosity is reached. To explain the subsequent increase in viscosity, it is necessary to take cognizance of the following facts: first, the percentage of ester sulfur is constantly decreasing, resulting in a constant diminution of the number of xanthate groups which make the ester colloidally soluble, secondly the loss in xanthate sulfur is accompanied by a corresponding decrease in free NaOH. In the third place, a constantly lower concentration of salt or acid solutions is sufficient to precipitate the viscose; and finally even the addition of water results in gelatinization. Any diminution in caustic soda content results in a higher viscosity. It appears quite possible that the combined NaOH (in the xanthate phase) is in osmotic equilibrium with the NaOH in the dispersion medium, the osmosis occurring through the boundaries of the disperse xanthate phase. As the xanthate decomposes, the percentage of NaOH in the xanthate phase decreases with simultaneous formation of sodium sulfide and thiocarbonate in the disperse phase. The solution pressure of these salts is sufficient to draw a large volume of water into the disperse phase, thus causing swelling, increasing viscosity, and finally

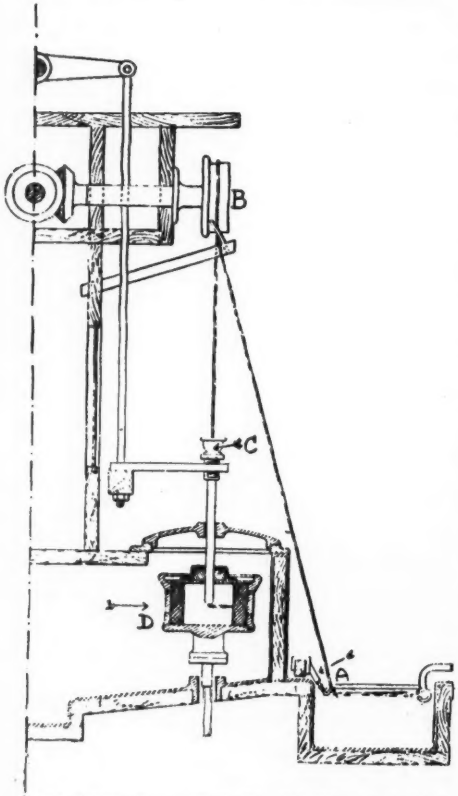


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FIG. 2.—DIAGRAM SHOWING CENTRIFUGAL BOX SPINNING PROCESS

A, guiding hook; *B*, revolving drum; *C*, verticle reciprocating tube; *D*, cylindrical box

[17] Venable, *J. Phys. Chem.*, **29**, 1243 (1925).

causing gelation. The addition of water to a very old solution is sufficient to cause precipitation because the NaOH concentration is already at the minimum necessary for the solution of the xanthate phase.

In practice viscose is aged for several days before "spinning," not merely to increase its susceptibility to coagulation by the spinning bath but also to confer certain fundamental properties upon the resulting rayon.

Rayon is made by the extrusion of viscose solution through minute orifices of spinnerets into a solution of acid and salt in which the sodium cellulose xanthate is first coagulated and then the cellulose regenerated in the form of endless filaments. The viscose is delivered to the spinneret by either a small piston or gear pump. For uniformity of thread it is essential that the viscose be delivered at a constant rate.

Two general types of "spinning" machines are used to collect the newly formed filaments. The Topham or bucket machine twists the filaments as they are collected and is an adaptation of an older machine used to twist asbestos twine. In this case the thread leaves the spinning bath and passes directly up and over a "Goudy" wheel, made of glass to resist the acid, and thence downward through a funnel into a small rubber or aluminum bucket traveling at 4000 to 5500 r. p. m. By this means the thread is twisted as it is "spun." Periodically the "cakes" of rayon are removed from the boxes either to be washed directly or to be aged.

In the bobbin type of spinning machine originally developed in Germany and Italy, the thread emerges from the spinning bath to pass over one or more guides which direct it to a large revolving glass bobbin. Periodically these bobbins are removed, the acid washed out and the rayon dried.

The spinning bath contains from 7 to 11% sulfuric acid, and 19 to 25% sodium sulfate except when glucose is used in which case the acid and salt are reduced. Sometimes about 1% of zinc sulfate is also used but it is not necessary to the production of satisfactory rayon. To a very limited extent magnesium sulfate is also employed. There are a large number of patents on spinning baths, but they are of little consequence. Napper's[18] patent covers the use of zinc sulfate, and there are a number of conflicting[19] patents on the use of glucose or similar compounds.

When the viscose first emerges from the spinneret a coagulation followed immediately by neutralization occurs. The thread itself consists of highly hydrated cellulose and acts as a dialytic membrane having the sodium

[18] U. S. Pat. 1,045,731.

[19] German Pat. 260,479; U. S. Pat. 1,367,603; U. S. 970,589; Eng. Pat. 192,214; U. S. Pat. 1,449,380.

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FIG. 3.—WASHING VISCOSE SILK SPUN ON BOBBINS

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FIG. 4.—REELING SKEINS FROM CAKES SPUN IN CENTRIFUGAL BOXES

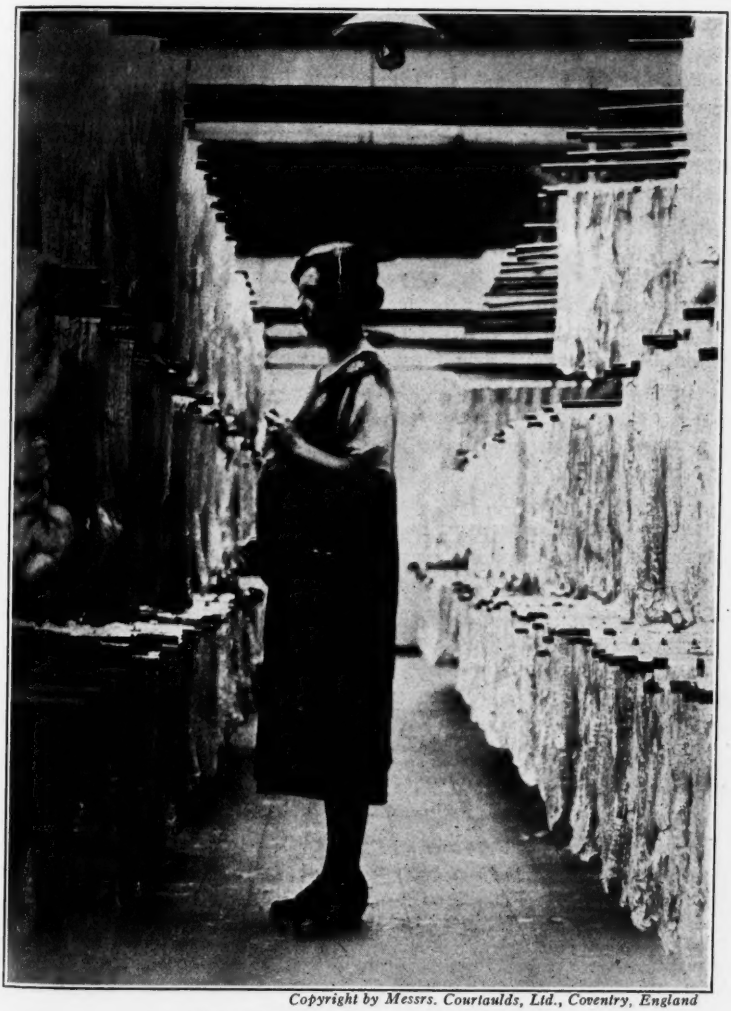

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FIG. 5.—RAYON-CONDITIONING ROOM

sulfate from the neutralized caustic soda on the inside of the thread with a concentration of about 14% and the spinning bath on the outside of the thread. If the salt concentration is high in the spinning bath a dehydration and shrinking of the filament takes place to produce a stronger, less elastic filament. If the salt is low in the coagulating bath an opposite effect prevails. When zinc sulfate is present in the bath the zinc cellulose

xanthate is formed in the initial stage of the coagulation and resists decomposition by acid much more than does sodium cellulose xanthate so that the effect is much the same as would be encountered in using a weaker coagulating bath. From what has been said it can be seen that the effect of increasing the NaOH content of the viscose is also much the same as using a more dilute spinning bath.

Rayon made by the bucket process is reeled directly from the "cake" while rayon is reeled from the bobbins in the latter process. In either case it is given a wash in an alkaline bath and bleached if desired.

The qualities which the rayon manufacturer watches and controls are tenacity, elasticity, luster, softness, and dye affinity. Nearly every one of the numerous variable factors which enter into the production of viscose and rayon affect these properties with more or less intensity. To produce uniform rayon, day after day, requires years of experience and it can be readily appreciated, therefore, why it took so many years of practical experimentation to realize the commercial exploitation of the viscose process.

The problems which still beset the industry fall into three general classes. First, improvement in the strength and elasticity of the rayon particularly by overcoming the peculiar property of rayon which causes it to weaken when wet. Secondly, the recovery of by-products or waste products such as caustic soda, viscose, spinning bath, etc., and lastly a simplification of methods which will result in cutting the cost of production. The most promising place to accomplish this seems to be in the elimination of some of the steps between the spinning machine and the bleaching of the rayon.

When these things are accomplished viscose rayon may well become the most important and useful of all textile fibers.

Mud Roads a Chemical Problem, Says Highway Board Chairman. In the early days, when an auto got stuck in the mud of a country road, the cry was "get a horse." Now it is "get a chemist."

The greatest challenge by the motorized world to the modern chemist that has not yet been answered is the challenge of the clay road, declared Charles M. Upham, chairman of the Highway Research Board of the National Research Council, speaking before the American Chemical Society. Clay, like everything else, will respond to chemical treatment, the speaker said. The chemist must somehow get it to do three things. He must treat it so that it will drain instead of absorbing water and turning into glue. He must cure it of its present disturbing habit of shrinking and swelling according to the amount of water it has taken up. He must increase its ability to bear loads when moist, and improve its workability by road machinery. The chemist who can do this will simply revolutionize road construction.

A further contribution which chemists may make to highway improvement is in the consistency of asphalt, preventing it from becoming exceedingly hard in winter and soft as putty in summer.—*Science Service*

THE ROLE OF MINERAL SALTS IN ANIMAL LIFE*

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When we think of the foods required for the growth and maintenance of the animal body we are very likely to consider the organic substances first. How many grams of protein are there in this meal? How many calories does the baby need? Not until recently have we heard the question—Have you had your iron today? It is not strange that the inorganic substances should be overlooked ordinarily because a well-balanced diet usually supplies enough of them. Nature provides with a generous hand.

Liebig, perhaps the first exponent of the modern theories of nutrition, emphasized the importance of inorganic salts. During the half century which followed, an era marked by the formulation of many important theories on protein, fat, and carbohydrate metabolism, only the occasional investigator dealt with the problem of the mineral substances. Mostly this work was overlooked until 1906 when a little book by Albu and Neuberg called "Physiologie und Pathologie des Mineralstoffwechsels" summarized it. This book still remains the only text devoted exclusively to this subject. The advance in our knowledge during the past twenty years has been so rapid that no textbook could long remain complete.

The mineral requirements of the animal body are in part indicated by its mineral content, the ash remaining after we shall have been purified by the refiner's fire. The mineral constituents of the adult human body comprise 4.3 to 4.4 per cent of its weight and the following list indicates the elements approximately in the order of decreasing amounts: Ca, P, K, S, Cl, Na, Mg, Fe, I, F, to which Si and traces of Se, Mn, As, Ni, Cu, and Sn must be added. The latter occur in the body chiefly because they are present in food but some of them may fulfill as yet unknown functions. Any statement of the exact amounts of minerals found in the different organs is valueless because of lack of data and of the variability incident to different dietary habits or possible pathological conditions. Figures for ash constituents are difficult to interpret because some of the elements certainly do not exist in the body in inorganic combination. This is particularly true of S, P, and Fe. In general five-sixths of the ash of the body is in the bones and this is presumably subject to less rapid metabolic changes than the remaining one-sixth which is about equally distributed between the muscles on the one hand and the blood, tissue fluids, and organs on the other.

The blood plasma has been found to be very constant in its mineral content. As early as 1884 Ringer characterized a solution containing NaCl 0.7%, KCl 0.03%, $CaCl_2$ 0.025% as a physiological salt solution or

* From a paper given before the Rochester Section, American Chemical Society.

a normal saline solution because such a solution simulated the inorganic composition of the blood plasma. In normal individuals it is impossible to change these proportions even transiently by methods which are short of heroic. Notwithstanding the variable intake of these elements in the food, the blood contains a constant amount under normal conditions. Undoubtedly the kidney plays the most important rôle in the maintenance of these constant levels; the extent to which the organs and tissues can act as temporary storehouses is uncertain. It is interesting to speculate upon the origin of this inorganic make-up of the blood plasma. Physiologists with a paleochemical bent, realizing that the ratios of the three cations to each other are somewhat similar to their ratios in sea water, have suggested that when the kidney first became a functioning organ in the precambrian period it established the levels of plasma salts for all time. Ocean water must have been more dilute than it is now; during the succeeding ages NaCl has been constantly added; Ca and K have increased to a less extent because they are deposited from sea water at about the same rate as they are brought there by the rivers. Mg is more slowly deposited and hence this has also increased in sea water since that time. The fact that marine animals possessing no kidneys have the same concentration of inorganic salts in their body fluids as exists in their environment lends additional interest to this speculation.

How we came to have this endowment of salts in the blood is less important than the consequences of our possessing it. These salts produce an osmotic pressure equivalent to $\Delta = 0.5$–$0.6\,^{\circ}C.$ to which the body is, of course, adapted. The maintenance of this osmotic pressure is not the whole story for each ion has a specific action; the ratio between them is not a matter of indifference. The permeability of the protein-lipoid cell membranes is determined in large measure by antagonistic processes involving mono- and di-valent metals, Na and K *vs.* Ca. They determine the ebb and flow of liquid across the membranes separating one cell from another and upon this ebb and flow depends the activity of living tissue. The prompt cessation of the heart beat of a frog when Ringer's solution is replaced by NaCl solution of equal concentration and the monumental experiments of Loeb on artificial parthenogenesis show that salt antagonisms are involved in the most intimate and fundamental processes of cell life.

Sodium chloride, the only salt which we deliberately add to our food, presents a paradox in that, although it cannot be stored to any extent, its intake may nevertheless be maintained at a low level without deleterious effects. The chlorine required for the hydrochloric acid of gastric juice suffers no diminution on a salt-poor diet. Apparently under these conditions the body conserves its supply. It is a common experience that the taking of extra sodium chloride, *e. g.*, in salty ham, is followed by

thirst. The extra salt together with the water which it demands are quickly eliminated in the urine. In the condition known as edema (dropsy) there is a retention of salt and of water in the tissues and a salt-poor diet is recommended. When salt excretion can be initiated the water will follow. If there can be no storage of salt without water there can likewise be no storage of water without salt. Observations on men perspiring heavily in a hot environment showed that the excessive loss of water (and salt) in the sweat could not be made good by the drinking of water alone; a dilute salt solution was required.

In normal individuals most of the salt of the food simply makes an excursion through the body, being secreted into the urine as fast as it is absorbed from the alimentary tract. If this is so, why do we eat it in such liberal amounts? This question can be answered by the little girl's definition of salt which was that "salt is something that spoils everything you don't put it on." The question as to why food tastes better with salt than without it is not so easily answered. The differing habits of herbiverous and carnivorous animals show that the desire for salt is not an acquired taste but a fundamental requirement. Hebrew and Roman law both specified that vegetable sacrifices must be accompanied by salt while animal sacrifices were acceptable without it. Many years ago Bunge formulated a theory to explain why herbiverous and carnivorous animals, both receiving in their food equal amounts of sodium chloride, should show such an unequal requirement for more of it. Since vegetable foods contain very little sodium and a great deal of potassium, he reasoned that the excess potassium ingested by herbiverous animals caused a loss of sodium from the body, a loss which had to be made good by extra intake. He was able to verify this on himself by showing that the ingestion of potassium did actually increase the sodium output. This theory remained unchallenged and without further proof until very recently when it was verified in part. The eating of salt in generous amounts has never been proved to be damaging. Restriction in cases of kidney disorder and high-blood pressure is directed rather to the sparing of the kidney. A recent observation of great interest indicates that with a subminimal salt intake there is less efficient utilization of food in the tissues. The character of the food determines what the body requires.

In another respect the character of the food determines the amount of minerals required. The oxidation of our foodstuffs involves acid formation, carbon going to carbonic acid, sulfur to sulfuric, and phosphorus to phosphoric. Carbon dioxide, eliminated as such by the lungs, involves only a temporary neutralization. Sulfuric and phosphoric acids, on the other hand, are eliminated in the urine as the neutral or acid salt, respectively. Foods are classified as acid- or base-forming according to the nature of their oxidation products; meat, eggs, cereals are acid-forming

because of the preponderance of S and P over metal ions; milk, fruits, and vegetables which contain acid salts of organic acids are base-forming because on combustion of the organic portion, the cation is available for the neutralization of acid. An ordinary mixed diet yields a neutral ash, while a high protein diet containing meat and cereals and but little fruit and vegetable is an acid-forming one. The progress of experiments with ash-free diets is always accompanied by an acidosis due to the impoverishment of the alkali reserve of the body. Whether the prolonged use of a mildly acid-forming diet may produce definite damage in the body remains to be determined but such work as has been done indicates that fruits and vegetables should be a part of the diet for this reason if for no other, that they maintain a store of alkali to neutralize the acid products of metabolism which are being produced constantly.

It is possible that calcium participates in this neutralization but this element is of particular importance in connection with bone formation. It is well known that the bones of children contain less ash and more water than those of the adult. The process of calcium enrichment begins before birth and does not cease until maturity, if then. The amount of calcium required by children has been variously estimated. At six to seven years of age 300 to 500 mg. of calcium oxide per day are necessary. At fourteen years 600 to 900 mg. During the first year or two of a child's life when milk is almost the sole food there is little danger of a shortage because milk contains lime in abundance and in available form. Even if the mother's diet is low in calcium the milk calcium persists because the maternal organism sacrifices its own stores to maintain an adequate concentration in the milk. Obviously an adequate supply of calcium in the food of the mother during pregnancy and lactation is of extreme importance. It is equally important that the diet of children should contain adequate supplements when milk ceases to be the sole food. Milk should always form a part of a child's diet and vegetables are next in the order of importance. A quart of milk per day has been set as a desirable standard for children up to the age of fourteen years. For adults in whose diet milk and its products are often not prominent, vegetables are the only adequate source of calcium, because meat and cereals are Ca-deficient foods.

While calcium fulfills many unexplained functions in the body (such as making possible the coagulation of the blood) it is required in largest amounts for the growth and maintenance of bones and teeth. The process of bone formation is still mysterious, a constant deposition, solution, and redeposition of calcium salts. Children may have adequate calcium in their food and yet fail to have proper bone formation, a condition known as rickets. The cause of rickets heretofore believed to be dietary or environmental appears to be both. The dietary factor for the cure of rickets

has long been recognized as occurring in cod-liver oil, has recently been christened vitamin D and appears to be related to sterols. By a mechanism which is not understood this accessory facilitates the deposition of lime in bone even under unfavorable circumstances of intake. The environmental factor is sunlight, specifically the ultra-violet portion, and it has been said that a poor mineral supply with vitamin D or with sunlight (direct and not through glass) is better than a good supply without them. How radiation accomplishes its results is not clear. A child with manifest rickets in one arm is cured by the radiation of the other arm. The milk of a cow at pasture contains more vitamin D than when she is stall fed. A beginning has been made in the understanding of this curious situation by the discovery that by radiation a food devoid of antirachitic activity is endowed with such property; the capacity to be activated apparently resides in the unsaponifiable portion of fats, in substances related to the sterols. The presence of very minute traces of sterols in foods permits them to become antirachitic agents when radiated. This fact suggests the mechanism by which radiation of the animal may cure rickets, the sterols in the skin being activated by such portion of the rays as can penetrate. The further mechanism by which vitamin D brings about calcium deposition is also a matter of speculation. The blood of rachitic animals is known to contain a subnormal amount of inorganic phosphorus and the failure of calcium phosphate deposition may be due simply to a disproportion of the two ions in the blood such that the salt cannot precipitate. This supposition is plausible because vitamin D or radiation tends to restore the blood phosphate level to normal. The inquiry has been pushed back still farther and it begins to appear that the disproportion of calcium and phosphorus in the blood may reside in an abnormal behavior of the intestinal tract. Radiant energy has become a subject of liveliest interest but none of its phases is as important as a quickened concern for the welfare of the children of our pent-up cities.

While phosphorus may be inefficiently utilized under these and certain other conditions, a true phosphorus hunger is uncommon because of the ubiquity of this element. Organically combined with protein, fat, and carbohydrate it is found in nearly all foodstuffs and a shortage is rarely encountered except under conditions of dietary limitation. The mutual precipitability of Ca and PO_4 generally necessitates a study of both of these radicals whenever one of them is involved. Volumes have been written upon the occurrence of phosphorus, its nutritional history and its functions in the animal body.

Iron is found in organic combination in the nuclei of all cells and especially in the complex pigment hemoglobin, found in muscle and in the red blood cells (erythrocytes). Here its principal function is that of an oxygen carrier. Anemia is a condition in which the number of red cells or the hemoglobin,

or both, are reduced. Nutritional anemia, that is, one brought about by lack of iron in the food, is very difficult to produce in grown animals because of the care with which the body conserves its iron supply. In young animals such anemia can be produced by iron-poor food. A growing child requires ever-increasing amounts of iron, and it is strange that the child's first food, milk, should contain such small amounts of iron. Apparently nature provided against this contingency by depositing in the organs of a new-born animal, especially in the liver, relatively much more iron than is found in the adult. The small amount of iron which milk contains is believed to be particularly well utilized but it is of great moment that when the dietary is enlarged it should contain foods having abundant iron. Cereals are known to be deficient in iron. Eggs, meat, and especially vegetables are the important sources for children. The anemia which is ordinarily encountered by physicians is not nutritional in origin in the sense of a scarcity of iron in the food but rather the iron of the food is not properly utilized. The difficulty of the problem which has engaged the minds and hands of many workers is reflected in the fact that the marked superiority of liver tissue in curing some types of anemia has no relation to its iron content.

Iodine occurs in thyroxin, an important constituent of the thyroid gland which helps to maintain the normal activity of nerves and muscles. When a normal growing individual is deprived of adequate amounts of iodine the thyroid apparently attempts to compensate by an enlargement which when uncomplicated is known as simple goiter. This condition tends to be prevalent in the geologically older regions where iodine has been thoroughly leached out of the soil with the result that plants and animals subsisting directly and indirectly upon the soil incorporate less iodine in their tissues. The administration of small amounts of iodide in the drinking water or the table salt has been thought to remedy this regional lack and to diminish a prevalence of simple goiter. There are many complex relations between the size and activity of the thyroid gland and it would be very unwise for an individual with an already overactive thyroid to employ iodides medicinally.

Perhaps enough has been indicated to reveal the importance of a better understanding of the rôle of mineral salts in animal life. While furnishing no energy they control the metabolism of water, the normality of the tissues and the progress of energy-yielding and other reactions going on in them. These reactions and the organic substances involved in turn modify the requirements of the body for minerals. Only the first sentences of what, one day, will be a long chapter, have thus far been written.

RICHARD KIRWAN—CHEMIST, 1733-1812*

C. J. BROCKMAN, UNIVERSITY OF GEORGIA, ATHENS, GEORGIA

Richard Kirwan was apparently an important character during the last years of the phlogiston theory, though he has been severely neglected by most historians. Many of his writings are intimately concerned with the Stahlian doctrine of phlogiston, so that a thorough resumé of his work would entail, of course, a more or less complete discussion of the rise of the French school of Lavoisier. This is not possible in a short paper. It is only intended to give a glimpse of the great range of thought which he was able to cover, and also possibly to throw a little light upon the personality of the man.

He was born in Galway County, Ireland, in 1733, where he remained until his father died in 1741. His early education was completed at Poitiers where he evidently specialized in languages, for he became a prominent linguist and continually interspersed his conversation with foreign idioms. In 1754 he entered the Jesuit novitiate at St. Omer, but after a year resigned to return to London.

These were the days of the English Debtor's Prison. The morning after his marriage in 1757 to a daughter of Sir Thomas Blake, also of Galway County, Ireland, he was thrown into the Debtor's Prison for his new wife's debts.

Kirwan evidently had not found his vocation at the time of his marriage, nor even some years later, for in 1766 he was admitted to the Irish Bar and practiced for two years at law. Then he went into what was to be his life work—the study of science in London—in 1768. During this period he took the time from his science to be actively interested in the study of Greek.

The years 1777 to 1787 were fertile years for him in London. He learned to know the outstanding scientists of the day—Priestley, Cavendish, and also Burke—the continental philosophers were in constant communication with him. His home life must have been interesting, for he had a gathering of congenial people at his home every Wednesday evening; these meetings attracted much attention, and the scientists of the continent were always his guests when in London. His fame spread far, for Empress Catherine of Russia sent her picture to him.

Both Priestley and Kirwan had trouble in protecting their furniture and personal possessions from the fury of their enemies. Priestley lost his to his fellow-countrymen when they destroyed his property in the

* Paper read before the Section of History of Chemistry of the A. C. S., April 13, 1927.

The writer's interest in the work of Kirwan originated through the reading of a paper entitled "Forgotten Chemists," by Dr. Edgar Fahs Smith, printed in THIS JOURNAL, **3**, 29–40 (Jan., 1926). Kirwan's name was one of a large group.

Birmingham riots. Kirwan, however, lost his library to American Privateers who captured it enroute from Ireland to London in 1780.

Elected a member of the Royal Society in 1780, he was awarded its Copley Medal in 1782 for his papers on Chemical Affinity,[1] all of which were translated by Crell into German. He was very close to the German scientists for they were greatly attracted by his writings. In fact the German translation of his "Geological Essays" appeared before the English edition (1799) which was delayed by the Irish Rebellion. His "Elements of Mineralogy" (London, 1784) was translated into French, German, and Russian. All through the journals of Crell during these years continual reference to the work of Kirwan is made.

In 1787 he returned to Ireland and devoted his time to the interests of Irish science. In 1799 he was elected President of the Royal Irish Academy. His friends induced him to organize a science group to be known as the "Kirwanian Societies" over which he presided for about ten years. His charming personality was the very life of these meetings, for he was an accomplished linguist and very fond of music, especially Italian music. In 1799 he was a charter member of the British Mineralogical Society along with A. Aiken; the President, W. H. Pepys; the Secretary, A. Tilloch; and D. Mushet.

In his later years he became an odd character; he wore a slouch hat on even formal occasions; even in summer he received his friends at his home while he was stretched out on a couch before a blazing fire; his diet of ham and milk, because of a weakness of his throat, was eaten alone.

He was a good landlord, and having inherited the family estates at the death of his brother in a duel, he must have received a good income, because he was entirely indifferent to money matters. The Unitarian belief satisfied his religious requirements. In an attempt to "starve out" a cold he died June 1, 1812, at the age of 79.

The following obituary notice appeared in the *Gentlemen's Magazine*:[2] "June 23, 1812: In Dublin, Rich. Kirwan, esq. of Gregg, co. Galway, Fell. of the Royal Society, President of the Royal Irish Academy, President of the Dublin Literary Society, and member of almost every literary Body in Europe."

The reaction of the contemporary scientists toward the work of Kirwan is of interest, because it shows how well he was appreciated by his fellowmen. Crell[3] wrote as a note to a letter from Kirwan, giving a very free translation: "This opinion of a man like Kirwan, whose works all foreign chemists know and read, very greatly honors the man as well as the nation

[1] *Phil. Trans.*, **71–73** (1781–3).
[2] *Gent. Mag.*, **82** (i) 669 (1812).
[3] Crell's, *Ann.*, **2**, 335–7 (1782).

which possesses him." Under the heading, "Literary News,"[4] the Editor, apropos of three of Kirwan's books which were in press, wrote as follows: "That most learned, indefatigable, and amiable cultivator of science, R. Kirwan, Esq. is now in London, where he has been for the last three months. With sincere pleasure we can announce that this revered veteran is printing and preparing for the press three valuable works:— . . .Of this philosopher permit us to indulge in the wish—*Sero in coelum redeat.*"

Luke Howard, Esq., F. R. S.,[5] in a paper wrote: "Having since perused the excellent work of my friend John Dalton[6] which I have before alluded to, and having seen and repeated some of the principal experiments therein detailed I must acknowledge that, although I might plead the authority of a Kirwan[7] in support of the chemical theory of evaporation, I am now disposed to give up the idea of a proper *solution* of air in water *in toto*."

Stephen Dickson dedicated his book, "An Essay on Chemical Nomenclature," to Kirwan in these words:

DEDICATED TO RICHARD KIRWAN, ESQ.

Dear Sir:

You add to the obligations already conferred on me, by your kind acceptance of this testimony of my respect and esteem. I am not solicitous to praise that merit of which all the cultivated part of the world so well knows the value. But I am happy to embrace this opportunity of indulging the sentiment of veneration for preëminent science and virtue, which a contemplation of your character cannot but excite.

I am,

Dear Sir, your most devoted, very humble servant,

Stephen Dickson.

Even in the vein of criticism, the greatness of the reputation of Kirwan for scientific and intellectual honesty is evident. He was not infallible, as the next two quotations indicate. Thomas Henry[8] took issue with Kirwan on a subject, and among other things writes:

But Mr. Kirwan's experiments are more worthy of attention. His accuracy in everything he undertakes is undeniable; nor would he probably have erred, but in a case in which the most faithful Experimentalist might be liable to deception.

Another example from the pen of John Dalton:[9]

Mr. Kirwan, like other men, is fallible; he has certainly committed an oversight in drawing up the table in question, which it would be easy for me to point out; but I do

[4] *Phil. Mag.*, **4** (2) 329 (1799).

[5] *Ibid.*, **14** (3) 55–62 (1802).

[6] "Experimental Essays on the Constitution of Mixed Gases, Etc.," *Manchester Memoirs*, **5** (2) (1801).

[7] Kirwan, "Of the Variation of the Atmosphere," *Trans. Royal Irish Acad.* (1801).

[8] *Manchester Mem.*, **1**, 448–73 (1785).

[9] *Ibid.*, 2nd Series, **1**, 430 (1805).

not desire so invidious a task; more especially respecting one who has so well deserved of the philosophical world; only would I take this opportunity to caution others from taking too much credit, when they may easily satisfy themselves from their own experience.

Kirwan had made a mistake in building a table of some data which he took from the work of one Professor Schmidt. Dalton's advice was to do your own experimenting first, and trust the data of others afterward.

Gerding[10] wrote that the Royal Irish Academy had no outstanding chemist who exerted a real influence on the course of scientific endeavor besides Kirwan, who deserved mention.

Thus having placed the man in his times, some of his writings will next be considered. Three papers will be considered together, namely: "Experiments and Observations on the Specific Gravities and the Attractive Powers of Various Saline Substances,"[11] the "Continuation of the Experiments and Observations on the Specific Gravities and Attractive Powers of Various Saline Substances,"[12] and "Conclusion of the Experiments and Observations Concerning the Attractive Powers of the Mineral Acids."[13]

By the previous work of others, and by his own work, Kirwan had been "enabled to determine pretty exactly the proportion of the ingredients of many neutral salts, and the specific gravity of the mineral acids in their purest state, and free from all water."

By using the principle of allegation Kirwan was able to calculate the specific gravities of mixtures, which values he termed the *mathematical* specific gravities. But

> The specific gravity of compounds, found by actual experiment, seldom agrees with that found by calculation, but is often greater without any diminution of the lighter ingredient. This increase of density must then arise from a closer union of the component parts to each other than either had separately with its own ingredient parts; and this more intimate union must proceed from the attraction or affinity of these parts to each other: I therefore imagined this attraction might be estimated by the increase of density or specific gravity and was proportional to it, but was soon undeceived.

On the basis of this method Kirwan was able to determine the quantity of "spirit of salt" in the aqueous product, the strength of solutions of "vegetable alkali," etc. He studied changes in density on mixing water with the various acids and from the data so obtained he was able to determine the affinity or attraction of the various compounds for water.

Kirwan then set himself to determine how much of the mineral acids were "taken up at the point of saturation by each of the metallic sub-

[10] Gerding, "Geschichte der Chemie," Leipzig, 1867, p. 117.
[11] *Phil. Trans.*, **71**, 7–41 (1781).
[12] *Ibid.*, **72**, 179–236 (1782).
[13] *Ibid.*, **73**, 15–84 (1783).

stances and for this purpose procured the most saturated solution possible of each metallic substance soluble in any of these acids." To this it might be well to add the following quotation: "The acids I used were dephlogisticated so far as to be colorless; the metals were for the most part very fine filings, or reduced in a mortar to a fine powder. They were added little by little to their respective menstruums, much more being thus dissolved than if the whole was thrown in at once; and the solution was performed in glass phials with bent tubes." He studied the solution of iron, copper, tin, lead, silver, mercury, zinc, bismuth, nickel, cobalt, regulus of antimony, regulus of arsenic, in "vitriolic, nitrous, and marine acids," and gold in aqua regia. These investigations were made with the aim to "ascertain the measure and degrees of affinity or attraction that subsist betwixt the mineral acids, and the various bases with which they may be combined, a subject of the greatest importance, as it is upon this foundation that chymistry, considered as a science, must finally rest; . . ."

From Kirwan's work on specific gravity and the quantities of mineral acids required to saturate the alkalies, he was able to get these two ideas: "That the quantity of real acid, necessary to saturate a given weight of each basis, is inversely as the affinity of each basis for such acid." And secondly "that the quantity of each basis, requisite to saturate a given quantity of each acid, is directly as the affinity of such acid to each basis."

The three papers cover about 160 pages of the *Philosophical Transactions* and are masterpieces of experimentation and conclusion. The results obtained were considered so important that the Royal Society awarded Kirwan the Copley Medal.

Most historians of chemistry at least mention the fact that Kirwan was one of the supporters of the Stahlian doctrine of phlogiston. He was one of the chemists who confounded phlogiston with our present-day hydrogen, and with all seriousness tried to prove their identity.[14] This was not an unusual confusion in those days, but we must not linger to discuss his work on phlogiston because the results of the controversy are too well known.

It has been stated in many places that Kirwan recanted all his defense of phlogiston in 1791 and turned over to accept the French doctrine of Lavoisier. So far, no record of an original statement by Kirwan has been found in the literature which would lead one to consider that he really did change his views. All his biographers and all his biographical notes indicate that he was "converted," and practically all "Histories" include a statement to this effect, but the original statement of Kirwan has not been uncovered by the writer. However, the search is being

[14] "On Phlogiston," *Phil. Trans.*, **72**, 195–236 (1782).

continued, though it is barely possible that Kirwan never wrote into the literature that he was "converted."

Morveau in 1782 laid down some rules concerning chemical nomenclature in which Kirwan partially concurred, but also in part rejected. The rules were based on the use of the phlogistic element and so when the new nomenclature on the French doctrine of oxygen and hydrogen was developed some changes were necessary. Kirwan studied the rules of Morveau, rejecting and commending when he deemed it proper: "Phrases are not a name; that substances and chemical products should be denoted by names fit to indicate them on every occasion, without having recourse to circumstance" was a rule which received the "entire assent" of Kirwan. Another rule of Morveau: "In choosing denominations we should prefer those which have their roots in the dead language more generally known, in order that the sense should suggest the name, and the name the sense." Kirwan wrote concerning this: "It is for this reason, combined with the first, that I prefer single names, already understood, and well known by all those that have attained any knowledge of chemistry, to new names derived from the Greek or new barbarous Latin names." Kirwan preferred the term "*hepar* to the unknown Latin term *sulphuret*, and also *pyrites* and *galena* to *sulphuret of iron*, or *copper*, or *lead*" when indicating compounds of the metals and sulfur.

Some students of chemical nomenclature during this period desired the new terms as "being more exact, sonorous, and significative, for any term is exact and significative when it denotes, without obscurity or ambiguity, the thing signified; and as to sound, it may deserve attention in poetry, but surely, if not exceedingly uncouth, it deserves none in science." And these men argued that though these alterations might embarrass their contemporaries for a time, the chemists of the future would be blessed by the change. To this Kirwan wrote, "I think on the contrary that they (meaning the new names) will curse them, for obliging them to learn both the new and the old denominations under the penalty of not understanding Stahl, Henkel, Margraff, Lemery, Geofroy, Duhamel, Macquer, Bergman, Scheele, and many others of the highest merit. Can any one be so arrogant as to pretend that these immortal authors can become unintelligible without prejudice to the science?" This quotation speaks for itself in the light of 1927 nomenclature.

Concerning another generalization of Morveau "the denomination of a chemical compound is neither clear nor exact except it expresses by names comfortable to their nature the ingredients that enter into that compound." Kirwan was of the opinion that "this maxim, unhappily too easily adopted by the French school, tends to the subversion of the received language of all sciences, and even of common life. By this rule we are to banish the name *water*, and instead of it substitute its

component ingredients *hydrogenated oxygen* or *oxygenated hydrogen;* instead of *ice* we are to say *decaloricated hydrogenated oxygen*, and for *steam*, *caloricated hydrogenated oxygen*. Instead of common *soap* we are to say *oleaginated soda*, and for *glass*, *silicited alkali*, etc. . . ."

Kirwan suggested that "the unexceptional name tartarin" be used instead of the usual "*salt of tartar*, a name certainly improper."

For the same reason I reject the name *ammonia* to express the volatile alkali, as the name *ammoniac* has always been employed to express the combination of a *volatile alkali* with an acid, and, if no particular acid was expressed, the muriatic was understood; instead of volatile alkali, which is a compound denomination, I substitute *volalkali*, whose signification cannot be mistaken. Its adjective is not, indeed, quite so happy; instead, then, of *volalkalised*, I use the word *fulginated*, which easily indicates the same idea.

The term *oxide* is also unsuitable to our language, in which it naturally expresses the *hide of an ox*. In pronunciation they cannot be distinguished; in its stead I would use *oxat* or *oxidat*, and instead of *oxided* I would substitute *oxidated*.

Lavoisier says:[15]

The only way of avoiding these errors (unfounded hypotheses) is to suppress reasoning, or at least to simplify it as much as possible, as it proceeds from us, and can alone lead us astray; to try it always by the test of experiment, to preserve only the facts, which are the data given by nature, and which cannot deceive us; to seek for truth only in the natural concatenation of experiments and observations, as mathematicians arrive at the solution of a problem by the simple arrangement of the data, etc.

The conclusions of Kirwan on this are that "from this paragraph we might be led to conclude that all reasoning should be banished from chemical investigation, or, at least, that only the simplest should be admitted; yet it may easily be shown that the most signal instances of successful chemical investigation in the obscurest subjects, and the happiest display of chemical sagacity, are the results of very complicated reasoning. Such as Bertholet's theory of aqua regia, Bertholet and Welter's observations on hepatic air, Fourcroy's on hepatic waters, Vauquelin's theory of the mutual decomposition of nitrous air and the solution of vitriol of iron, most of Scheele's and many of Klaproth's analyses, and a few others."

Lavoisier and Morveau believed that the memory of learners is singularly relieved by compound denominations expressing the component ingredients of each compound. "In reply to which, I (that is, Kirwan) say, that the science is not to be charged with a cumbersome train of words merely to gratify the indolence of beginners."

These quotations are very interesting in the lights and shadows which have been cast during the passage of a century and a quarter. Some of the theses of Kirwan we would do well to revive; others have been lost in the dimness of the distance of his day. As to his prophesies, little can be said. Of the "immortal authors," possibly only Scheele is re-

[15] "Treatise on Chemistry," page 10.

membered by the average chemist who has not a very definite interest in the historical side of chemistry. Have the works of these *savants* become unintelligible to the modern students? Possibly not so meaningless as they are difficult of being correctly interpreted. It is difficult to project oneself backwards in time to that period (especially in the light of our modern views on these same subjects) and realize how these philosophers were really in earnest concerning what we would now term absurd ideas. The student must become thoroughly imbued with the spirit of the age if he is to gain an insight into the philosophical development of the phlogiston theory and its subsequent elimination as a working hypothesis.

Kirwan's "Elements of Mineralogy" (1784) and his "Geological Essays" (1799) are not of direct interest to the chemist. The latter work began a long and bitter polemical controversy with Playfair who was championing the Huttonian theory of the universe. Some of the bickerings are interestingly acrimonious. Kirwan and De Luc were known as Neptunists as opposed to the Vulcanists, regarding the origin and the development of the earth into its present shape and condition.

In his later years Kirwan turned to philosophical contemplation. In 1802 he published his "Logik," and in 1811 "Metaphysical Essays," neither of which were very successful. The *Transactions of the Royal Irish Academy* after 1800 contain many papers on such philosophical subjects as "Essay on Human Liberty" in which he takes issue with some of Priestley's contributions to the science of metaphysics and human behavior. Other interesting titles are: "Of Duration, Time and Eternity," "On the Primeval Language of Mankind," "An Essay on Happiness," "On the Origin of Polytheism, Idolatry and Grecian Mythology."

Says Reclaimed Rubber Stabilizes Tire Trade. "Old rubber!" Once merely a part of the ragman's chant, these words have now become a powerful economic charm, operating in high-price years to soften the impact on the tire-buyer's pocketbook and in low-price years to save the tire-making industry from disaster.

The importance which reclaimed rubber has assumed in the industry, thanks to new chemical processes which have greatly improved its quality, was discussed by William C. Geer, of New Rochelle, N. Y., before the meeting of the American Chemical Society. In one year, Mr. Geer stated, the use of reclaimed rubber saved the consumer $55,297,000.

Another recent improvement which has been made in rubber is the addition of chemicals to slow down the rate of oxidation, which does to rubber what rust does to steel. Rubber articles have had their lives thus lengthened by from two to ten years, the speaker declared.

Mr. Geer doubts both the need and the commercial possibility of artificial rubber. American-grown rubber is in sight, and this, with further improvements in reclaimed rubber, will take care of our needs for a long time to come, he said.—*Science Service*

NUMERICAL PROBLEMS IN GENERAL CHEMISTRY

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What function do numerical problems perform in chemical instruction? What may the instructor hope to accomplish through this medium? The author discusses these questions and outlines a method of attack which he believes best fitted to take advantage of all the potentialities of problem work. Specific examples are included.

In all courses in general chemistry, a varying amount of emphasis is placed on the solving of numerical problems, based most frequently on the reacting amounts of various substances. Such calculations are taught in several different ways; but they usually involve the adoption of a definite mode of procedure, which in many cases amounts to little more than the substitution of numbers in a formula and then the carrying out of the necessary multiplication and division indicated by the scheme in use. The methods used in making these calculations usually receive considerable emphasis for a few periods at some time early in the course and receive little subsequent attention. In some cases, numerical problems are casually assigned at later periods, either as exercises to be solved and handed in or in the form of test questions. In other cases, problem work is more systematically administered by periodic assignments to books dealing primarily with this subject. Unless a very careful selection is made, the problems are likely to become "mathematical puzzles" in which the student sees no connection with the subject-matter under consideration. When this is the case, the student thinks of these problems as a device on the part of the instructor to make life more uncomfortable and the subject more difficult and uninteresting.

Reflection upon this subject leads naturally to the query, "Just what is the function of numerical problems in a course in general chemistry?" A previous writer in THIS JOURNAL,[1] has pointed out the importance of mathematics in teaching an appreciation of chemistry. The extent to which mathematics is used by chemists in the expression of facts has also been pointed out.[2] It is generally agreed that the solving of problems impresses on the minds of the students the significance of symbols and formulas—that these represent definite and exact weights of substances and are not merely abbreviations for names; and that reactions involve definite proportions of the reacting substances. If this is to be the sole function of the calculations, the desired result can be obtained most satisfactorily only when problems are constantly kept before the students

[1] H. P. Ward, "Arithmetic in First-Year Chemistry," THIS JOURNAL, **3**, 568–70 (May, 1926).

[2] B. C. Bradshaw, "Relation of Mathematics to Chemistry," THIS JOURNAL, **3**, 1293–6 (November, 1926).

and when these problems bear a close relation to the class work under consideration, instead of being used merely for the purpose of furnishing something to calculate.

The solving of numerical exercises may, however, serve other useful purposes. The significance of many of the topics discussed in the course can be understood by the beginner more clearly through the medium of problems than in any other way. Many of the industrial and practical applications of chemistry can be clearly demonstrated in this way. Problems serve as an effectual review of the fundamental concepts of the subject in such a manner that the student uses the real meaning of the concept, instead of merely repeating the words of the textbook statement. Among these may be mentioned the fact that no change in the total amount of the reacting materials is noted during chemical reactions; that substances possess a definite composition by weight and consequently a given reaction involves definite proportions of the reacting substances; that, if the substances are gases, the reacting ratio by volume is expressible in small whole numbers; that these numbers are the same as the coefficients used in the balancing of the equation, because under the same conditions of temperature and pressure equal volumes of gases contain the same number of molecules. Problems involving gases serve also constantly to emphasize the significance of the "gram molecular volume" as a definite amount of the substance. Problems involving volumes of solutions serve to give a clear understanding of the meaning of the terms: "molar;" "normal;" "gram equivalent weight."

In addition to these points, problems should emphasize the fact that the mol is the chemical unit by weight of the substance. We consider the molecule to be the unit particle of a pure substance, and that changes in the composition of molecules occur during chemical reactions. When we write an equation, we represent a reaction and show how many of these particles are involved in the change; but, since we are not in our actual experiments dealing with this small number of particles, we say that this is just a ratio and that this unit change is taking place millions of times in test tubes in such experiments. The relative weights of these molecules we have called molecular weights; and we find it more convenient to use these numbers in preference to the actual weights of the molecules themselves. Having committed ourselves to these numbers—molecular weights—we should, in our calculations, emphasize their significance. These units, which are different from the ordinary units of weight—grams—are changed to the common system of weights by the use of the concept of gram molecular weights, which weights express the actual weights in grams of the same large number of molecules in each case. As expressed in the ordinary units of weight, the gram molecular weight—mol—is, therefore, to be regarded the chemical unit of weight.

Problems should be introduced and solved in a manner such that these important considerations stand out. The actual numerical answer, for the purposes for which problems are used in courses in general chemistry, is of minor importance. It seems that far too much emphasis is ordinarily placed on a scheme for securing a correct answer with a minimum of thought on the part of the student. The student is often told always to write a proportion in a certain specified order, and that he will get the right answer when he solves the proportion. Of course he will get the answer when he does this, but will he accomplish anything else? Although this method of making the calculations may teach a certain amount of dexterity in the solving of puzzles, it neither teaches nor tests the student's knowledge of the fundamental principles of chemistry.

In a previous paper on this subject,[3] the writer urged the solving of problems in chemistry by the use of a "common-sense" method of attack. Possibly "common sense" is the wrong designation, and it should be called a method based on "chemical sense." The intent of the expression is that problems should be solved by the application of the fundamental concepts of chemistry, consciously instead of unconsciously as is likely to be the case when someone else has done all of the thinking for the student and left him with the simple task of substituting numbers. The arithmetic involved in making the solution of these problems is so simple that no student, who has gotten so far in the pursuit of an education as the study of chemistry, can have the slightest difficulty on this score. It is the chemical part of the "chemical arithmetic" that causes the trouble. Instead of avoiding this difficulty by developing a scheme in which the student substitutes numbers, we should use methods which force thought and develop the chemical significance of the problem. In this way, the student develops the habit of correlating the definitions which he commits to memory with the calculations which he makes; and then he is in position to understand clearly the meaning of the definition.

It is unfortunate that different methods of attack in solving the same simple problems are so generally used, for this serves to confuse the student who has had one method given him in his school course and then gets another method in the college work for solving the same type of problem. It is confusing unless the student really knows the background for what he is doing. Recently, the writer heard a discussion, at some length, of the proper form of expressing the numerical proportion in chemical problems. The question was whether the proportion should be expressed in the form of two equal fractions or by the use of the signs of proportion. The simplest answer is to omit the use of proportions entirely and solve the problem as other simple problems in arithmetic are solved.

[3] THIS JOURNAL, 2, 136–41 (February, 1925).

The method of attack, which the writer uses in teaching this phase of the subject, is that outlined in the above-mentioned article; *i. e.*, to make the calculation in terms of the fractions of mols of the reacting substances. A modification of procedure has been introduced which seems to make the work even simpler and the application of principles clearer. In emphasizing the quantitative relations, the student's attention is directed to the fact that amounts of substances are usually measured in terms of weights, expressed in grams; but that in the case of gases the volumes under specified conditions of temperature and pressure are more frequently used. A third method of expressing the amount of a substance is in terms of the volume of a solution of specified concentration. The equation for the reaction expresses the amount of the reacting substances in terms of mols. Consequently, the only thing left in the calculation is the conversion of the mol fraction into the units of measurement called for in the specific problem. When these problems are solved at the blackboard, an important part of the work is the discussion by the student of the principles upon which the solution of the problem rests.

The solving of problems involving weights, volumes of gases, or volumes of solutions is made in the following manner. (1) The equation for the reaction is written. (2) By means of formulas, the equivalence in mols of the substances concerned in the specific problem is stated. (3) The amounts of the substances represented by this equivalence is stated in the units of measurement involved in the problem. (4) The calculation in terms of fractions of these quantities is made. A few examples will aid in visualizing and evaluating this procedure.

Suppose it is required to calculate the weight of sodium chloride obtained by the neutralization of 5 g. of sodium hydroxide with hydrochloric acid.

$$NaOH + HCl \longrightarrow H_2O + NaCl$$

1 mol of NaOH $\equiv$ 1 mol of NaCl

40 g. of NaOH $\equiv$ 58.45 g. of NaCl

5 g. = $^5/_{40}$ of 1 mol of NaOH $\equiv$ $^5/_{40} \times 58.45$ g. = 7.306 g. of NaCl.

To illustrate a second case: What volume of carbon dioxide (standard conditions) would be evolved by the reaction of 5 g. of calcium carbonate with hydrochloric acid?

$$CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$$

1 mol of $CaCO_3 \equiv$ 1 mol of CO_2

100 g. of $CaCO_3 \equiv$ 22.4 liters of CO_2

5 g. = $^5/_{100}$ of 1 mol of $CaCO_3 \equiv$ $^5/_{100} \times 22.4$ = 1.12 liters of CO_2.

If the gas is measured at 20° and 740 mm., the correction, made by in-

spection from the fact that this temperature is higher and this pressure is lower than those of standard conditions, is:

$$1.12 \times 293/273 \times 760/740 = 1.234 \text{ liters.}$$

As a third case: What volume of 5 N sulfuric acid would be required for the neutralization of 10 g. of sodium hydroxide?

$$2NaOH + H_2SO_4 \longrightarrow 2H_2O + Na_2SO_4$$
$$1 \text{ mol of NaOH} \equiv {}^1/_2 \text{ mol of } H_2SO_4.$$

Five normal sulfuric acid contains 5 gram equivalent weights per liter of solution; *i. e.*, $2^1/_2$ mols per liter; but only $^1/_2$ mol is required. If there are $2^1/_2$ mols in 1 liter of the specified solution, $^1/_2$ mol is present in 200 cc. Hence,

$$40 \text{ g. of NaOH} \equiv 200 \text{ cc. of 5 } N \text{ } H_2SO_4$$
$$10 \text{ g.} = 10/40 \text{ of 1 mol of NaOH} \equiv 10/40 \text{ of 200 cc.} = 50 \text{ cc. of 5 } N \text{ } H_2SO_4.$$

A final example serves to illustrate the calculation when the amounts of both substances are expressed in terms of solutions of specified concentration. What volume of 0.5 N sodium hydroxide is required for the neutralization of 100 cc. of 0.2 N sulfuric acid?

$$H_2SO_4 + 2NaOH \longrightarrow 2H_2O + Na_2SO_4$$
$$1 \text{ mol of } H_2SO_4 \equiv 2 \text{ mols of NaOH}$$
$$10 \text{ l. of 0.2 } N \text{ } H_2SO_4 \equiv 4 \text{ l. of 0.5 } N \text{ NaOH}$$
$$100 \text{ cc.} = 100/10{,}000 \text{ of 1 mol of } H_2SO_4 \equiv 100/10{,}000 \times 4 \text{ l.} = 40 \text{ cc. of 0.5 } N \text{ NaOH.}$$

It will be observed that all of the problems are solved in exactly the same manner. The writer recognizes the fact that the last type illustrated above may be solved more directly, because the reacting volumes of solutions vary inversely with the normality; and that such problems would be solved in this manner by advanced students. He believes, however, that this requires reasoning somewhat advanced for the average student in a beginning course in general chemistry. The additional steps, used in the solution illustrated above, serve to emphasize the meaning of the term normal, and this is after all the purpose of the problem. The solving of all problems involving reacting amounts of substances by the same procedure greatly simplifies the work for the student; and it is but logical that all such problems should be solved in exactly the same manner, for they are merely different examples, involving the same fundamental concept of definite reacting amounts of substances.

This method of solving numerical problems in general chemistry seems to be the simplest and most direct method of attack. It is believed that in this way, problems may be introduced and solved so as to place the

emphasis on the real purpose of the problems, as set forth in the first part of this paper. The experience of the writer leads to the conclusion that students derive more benefit from this method of attack than from the substitution of numbers in a prescribed scheme; and also that they find it easier to make the required calculations because they see more clearly the principles involved.

UNITED STATES CIVIL-SERVICE EXAMINATIONS

The United States Civil-Service Commission announces the following open competitive examinations:

Chemical Engineer, $3800
Associate Chemical Engineer, $3000
Assistant Chemical Engineer, $2400

Applications must be on file with the Civil-Service Commission at Washington, D. C., not later than November 8th.

The duties of appointees will be in connection with original research and development, or design and construction, that is being conducted by the different bureaus in chemical engineering.

Associate Civil-Service Examiner, $3000
Assistant Civil-Service Examiner, $2400
(*Physical Science*)

Applications must be on file with the Civil-Service Commission at Washington, D. C., not later than November 8th.

The duties consist of the rating of papers, the preparation of examinations and announcements of examinations in physical science, consultation with department officials concerning matters of personnel, the holding of oral examinations, and the conducting of character investigations of applicants for Government appointment.

Senior Aid in Laboratory Technic, $1860

Applications must be on file with the Civil-Service Commission at Washington, D. C., not later than November 12th.

The duties consist of the recognition and separation of different species of scale insects and placing same in sub-families, tribes, and genera; the preparation of scale insects for study, including maceration and staining; and the preparation of analyses of morphological structures, including the proper orientation of the various body sclerites.

Junior Chemist, $1860

Applications for junior chemist must be on file with the Civil-Service Commission at Washington, D. C., not later than October 29th.

Optional subjects are advanced inorganic chemistry, analytical chemistry, organic chemistry, and physical chemistry.

Competitors will be rated on general chemistry, elementary physics, and the optional subject selected.

THE STUDY OF A SIMPLE CHEMICAL CHANGE. A LECTURE-DEMONSTRATION FOR BEGINNERS

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Beginners in chemistry are often introduced to the idea of a simple chemical change by the study of the effect of heating a strip of copper in the air. They observe the formation of a black crust and, by variation of the conditions under which it is formed, that the presence of air is necessary for the change. They readily understand from their experiments and the reading of the text that the oxygen of the air is responsible for the change, but fail to grasp fully the true nature of it. To aid them in the formulation of a clearer idea of what has happened the following demonstration experiment has been successfully used.

A piece of sheet copper with a total surface of about fifteen or twenty square centimeters is carefully counter-balanced on a rather sensitive balance. Since it is not the purpose to make actual weighings but only to notice weight changes the counter-poise is not disturbed throughout the experiment. The strip is removed and heated until a good coating of oxide is formed and then allowed to cool, care being taken to save all of the crust which has a tendency to peel off. The strip, with any crust which may have fallen off, is put back onto the balance pan and it will be evident that it has increased in weight. This shows that the oxygen of the air has become a part of the blackened strip. The crust is removed and the strip returned to the balance which will show the strip to be lighter than the original piece. This observation shows that the crust contains copper in its make-up. In order to add interest to the experiment and to establish more clearly the fact that the oxide contains copper, it can be reduced, and the freed copper shown as evidence.

This experiment has been used with a great deal of success and has never failed to increase the interest of the beginning students in their endeavors to understand the nature of chemical change. This experiment to be most useful should follow some work of the students themselves on the effect of heating of metals in the air. It should not be put into the hands of the student for greater care is needed for its performance than the average beginner is likely to exercise.

Cow's Milk Better Than Human as Rickets Preventive. The product of the cow has one advantage over the food traditionally supposed to be best for babies. Cow's milk is more effective as a rickets preventive than human milk, Dr. Icie G. Macy, director of nutrition research at the Merrill-Palmer School, told members of the American Chemical Society.

Thirty cubic centimeters of cow's milk daily for a week produced a marked healing of the bone lesions in young rats with rickets, stated the nutrition expert, while the administration of 40 cubic centimeters of human milk daily had no effect on the condition of the rickets.—*Science Service*

LABELS

A. T. BAWDEN, BAYLOR COLLEGE, BELTON, TEXAS

The author points out that proper labeling is not only essential to neatness and order in the laboratory and contributory to efficient work, but has educational value as well. He discusses methods of labeling which have proved satisfactory in his own laboratory.

By their labels shall they be known. The other day I visited the chemical laboratories of a sister institution. In talking with other people who have visited these laboratories I find that I received the same unfavorable impression that they did. It may be that a high grade of work is done there, but we doubt it. What did I see?

I found laboratories with no definite location for reagent bottles, and no apparent system in labeling them. All sizes and shapes of labels were used on almost any part of all kinds of bottles. Many labels were scribbled with pencil. Even in the general chemistry laboratory, the bottles were labeled with names or formulas, never both. Many names and formulas could scarcely be deciphered by an experienced chemist. No labels were protected against the action of fumes, acids, alkalies, etc. Observation showed that the condition of the rest of the laboratory was similar to that of the labels.

We wonder how many laboratories would be willing to be known by their labels. We would probably pass by a store with poorly executed display and price cards. It might have high-grade merchandise, but it probably would not.

The main purpose of a label on a bottle is to tell what the content of the bottle is, accurately and quickly. It may also have a positive educational value.

A good label should be printed in large, legible letters and figures. Neatness demands uniformity. Uniformity requires that the same size label should be placed on similar bottles in the same relative position. This means that bottles of the same shape and size should be used as far as possible. By using bottles of the same size, shelves may be made of the proper size to accommodate them. One bottle which is too large is sufficient to upset a system. Bottles should be arranged in a definite order (alphabetically, for example) to enable the student to know where to look for a desired reagent. In order to insure that this order is maintained, the bottles and the spaces which they occupy should be numbered. Correct labels are essential to neatness and orderliness in a laboratory.

The student learns many of his formulas from the labels on the bottles, and makes many a mistake because of a bottle incorrectly labeled. A correct label in an elementary chemistry laboratory should contain the

name and formula of the contents. In case the given substance has more than one name, the name used most widely in chemical literature should be in large type, all other names being given in small type or in parenthesis. All common names should be given for educational reasons. The formula should be complete and should conform to modern usage. For example, $CuSO_4.5H_2O$ should not be written $CuSO_4$. Wherever the concentration of a reagent is required, this should be indicated on the label.

In case some chemicals used are C.P. and others are not, all labels should indicate whether the reagent is C.P., commercially pure, technically pure, etc. There is a multiplicity of terms used to express the purity of reagents. We would like to have a committee appointed by the Senate of Chemical Education to standardize such terms.

In a few cases labels should contain additional information showing something about the method of preparation of the given reagent. For example, one qualitative text calls for the use of a solution of As_2O_3 in HCl as a test solution. If the bottle is simply labelled $AsCl_3$ solution, half of the students will ask the instructor if it is the correct solution to use. Another example: in the Marsh test for arsenic where arsenic-free zinc must be used, the label on the bottle containing the zinc for this test should indicate that the zinc is arsenic-free.

In order to insure the permanency of a label, it should be coated, immediately after application, with melted paraffin, white shellac, colorless varnish, pyroxylin, or some such protective coating. In case there are two sets of reagents, such as test solutions and reagents, which it is desired to keep apart, the protective coatings may be tinted with different colors. This is used in addition to the numbering system.

We have found that Dennison's books of numbers are excellent for use in numbering the bottles and the spaces on the shelves.

We have used the books of printed labels obtainable from the laboratory supply houses, because of the following advantages which they offer.

1. The characters are more legible than those which the majority of people would use.
2. The labels are uniform in shape, and the names and formulas are placed in the same relative position on each label.
3. The use of these labels is economical.

These books of labels are the same, no matter what the source, and present the following disadvantages:

1. There are no labels for many common substances.
2. There should be several labels for each of a number of the most common substances.

3. Some labels for substances such as sulfindigotic acid might well be omitted.

4. Many of the formulas do not conform to modern usage.

5. Such abbreviations as "sodium permangan." and "sodium carbon." are confusing to a beginner.

6. Provision should be made for indicating whether a reagent is C.P. or not, and whether it is a solution or not.

7. Common names are not given on the labels.

No company or individual is interested in developing a satisfactory book of labels, because it cannot be patented or copyrighted successfully. We would like to have this committee, which we suggested to be appointed, study this question of labels. It is almost certain that the supply companies would publish a book of labels worked out by a committee appointed by the Senate of Chemical Education. A good book of labels would be of definite educational value, and would help to solve the label problem in a chemical laboratory.

We might add that we have found that the process of removing labels is speeded up greatly by using a copper sponge ("chore-boy") such as is sold for domestic use. This is particularly valuable for removing labels which have been covered with one of the protective coatings mentioned above.

Dyes the Best Germ Killers, Chemists Find. Great hopes were held out for the future treatment of infectious diseases with germicidal dyestuffs by Dr. Hugh H. Young of the Brady Urological Institute at Baltimore speaking before the annual meeting of the American Chemical Society in Detroit.

Mercurochrome, in particular, has shown remarkable efficiency, not only in the local treatment of infections but by injection into the blood stream, Dr. Young declared.

"Over 1000 cases have now been collected of local and general infections," stated the scientist, "with a high percentage of immediate improvements and many really remarkable apparent cures. In some cases of blood poison where the condition was desperate the results have been remarkable."

Considerable effort has been expended, Dr. Young explained, to find dyes that are germicidal but not poisonous or irritating to the tissues and that are efficient in serum, bile, and other body fluids.—*Science Service*

Typhoid May Lurk in Oyster Juice. An additional danger of typhoid infection from oysters has been brought to light by Dr. William H. Park, director of the bureau of laboratories of the New York City Department of Health. He reports that the liquid in which shucked oysters are carried provides an excellent breeding ground for the typhoid bacillus. Bacilli from an infected oyster, therefore, not only may be carried by the liquid to other oysters but may increase during their sojourn in the liquid.

"Typhoid bacilli," he says, "have been shown to increase in the liquor of shucked oysters. With a sufficient rise in temperature the multiplication of typhoid bacilli that may be present will occur in the oyster liquid in which oysters are often transported. Thus the danger from a single infected bivalve is capable of being many times magnified by the time a consignment reaches its destination."—*Science Service*

NEW TECHNIC IN EXAMINATIONS

VERNON M. STOWE, NORTH DAKOTA AGRICULTURAL COLLEGE, FARGO, NORTH DAKOTA

The author has devised a comparatively simple instrument for giving examinations of the multiple response and true-false type. The device described herewith makes correction of examination papers of this type unnecessary, and thus assists in reducing demands on teacher time. It corrects pupil errors as they are made by causing the pupil to correct his mistake immediately, under penalty of having his score still further reduced. It records the grades in permanent form on mimeographed or printed blanks.

The purpose of this article is to present a simple inexpensive device to lighten the work of testing pupils and to increase effectiveness of examinations. Perhaps the device may be best described by taking the reader on an imaginary trip through the examination room.

One finds that a room has been set aside for the purpose. It is centrally located and may be near the library. It is lighted by subdued natural light, and preferably faces the north. Ventilation is excellent. One presently observes a screen and a reflection type of lantern. The lantern is able to project typewriting on the screen so as to be plainly visible without further reduction of light. About the room at comfortable distances are thirty fixed seats with desks. These desks have some space available for writing, and are also provided with four or more keys, similar to those of an adding machine. These keys are placed in a staggered position, and are marked with large upraised numerals on the tops of the keys. Let us now watch the course of a brief examination.

The pupils enter and take seats previously assigned. The teacher checks at a glance the condition of the adding device to be described later. The screen is illuminated and the examination questions are presented one at a time, either from an endless sheet of paper similar to a film, or from typewritten sheets placed in like plates.

The first question reads:

Atomic weight of O = 16; of H = 1. In order to produce 36 grams of water, we must use

1. 17 grams of hydrogen.
2. 4 grams of hydrogen.
3. 2 grams of hydrogen.
4. An indefinite amount of hydrogen.

After the question has been submitted a sufficiently long time, the pupils push down the keys bearing the numbers which they think represent the correct reply. Then the teacher presses a master key, which automatically records all the correct answers to the credit of each student,

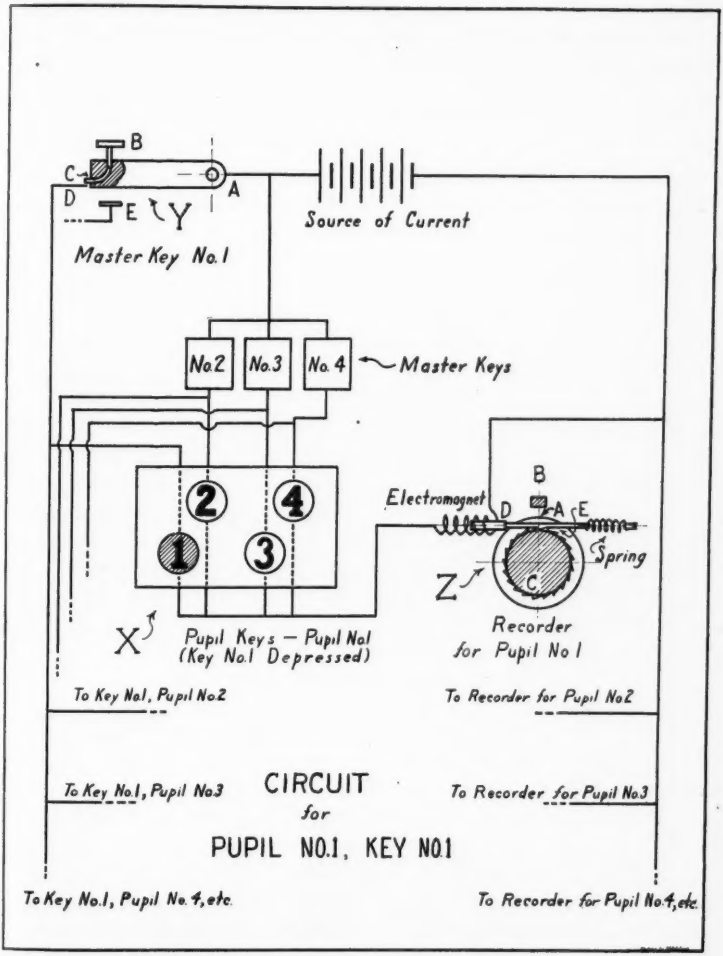
and then illuminates a little area behind the number "2" in a space near the screen. This informs the pupils whether they have replied correctly or not. The error is thus detected by the pupil himself and immediately after he has made the mistake. Moreover the machine may be so set that he is required to press the correct key, thus counteracting the effect of the mistake psychologically, or confirming his correct choice.

When all the questions have been answered the class is dismissed. While they are passing out, the teacher presses a lever which automatically totals and records in permanent form the record of each pupil. The teacher then "clears" the adding device, and leaves the room with the pupils. Some other class enters on schedule. The examinations last for perhaps ten minutes and are given very frequently. The room is kept busy continuously.

The simplicity of the operation will appeal to any teacher who has spent hours over correction of papers. It should appeal to the psychologist as one means of testing in which mistakes are detected by the pupil himself, and are corrected immediately by him under penalty. The device should appeal to the administrator or school board member who is interested in relieving his teaching staff as far as possible from routine clerical duties, that they may spend more time in the more profitable work of preparation of material and the assumption of other duties. The mechanical details are explained chiefly in the figure. The complete wiring diagram for Master Key No. 1 and for the pupil keys No. 1 is shown. There are four or more of these units, but each of the four circuits includes the same electromagnet for any particular pupil. Therefore, the pupil and the teacher must both press keys of the same number to affect the magnet and record a grade.

The keys are staggered in order to render them more distinctive, so that one will not press the wrong key. They bear upraised numerals for the same reason, as shown in part **X** of the drawing. Part **Y** shows the details of the construction of the master keys. *A* is a hinge and tension for the main part of the key. *B* is the button. When this is pushed down the pressure first pushes the tongue *C* out to the position shown, then depresses the whole key downward, swinging on *A*. The tongue touches the spring contact *D* momentarily, which permits a current to flow on through the circuit to the pupil key No. 1, then if that switch is closed, on to the electromagnet. As the key moves on downward, the contact at *D* is broken and a new contact is made at *E*. This allows a current to flow through a new circuit including the light behind the numeral near the screen and serves to inform the pupils which was the correct response. Now, if desired, the tension at *A* may be relieved and so regulated as to allow a strong upward pull by the spring, not shown. This keeps the tongue *C* out, and a second registration is made on the

upstroke, every pupil having in the meantime corrected his errors. The number of credits so given may be deducted from all scores, so that the pupil is required under penalty to correct his errors. Again, the tension



may be so regulated that the beam rises slowly, and the tongue has been withdrawn into the beam so that no contact is made on the upstroke.

The recording device is shown in part **Z** of the drawing. If both the master key and the appropriate pupil key are closed, a current will flow through the electromagnet, pulling on the bar *D*, As this moves to

the left a catch on the bar engages a lug and moves the wheel C counterclockwise a certain distance. This also revolves the concentric wheel A, which is attached to the wheel C, and has on its diameter a rubber stamp containing numerals. The first of these characters may be the letter "a," signifying an absence. When the current has passed, the spring replaces the bar, where it engages the wheel C at a new lug. At the conclusion of the examination the grades are automatically recorded by inking the type, then pressing a sheet of prepared mimeographed paper against the type at A by means of the pad B. This pad extends along the thirty or more recorders, and prints all at one stroke.

The complete outfit will thus require four (or more) items of part **Y** of the figure, one source of recording current, one lantern and screen, thirty or so items of part **X** of the figure, and the same number of part **Z**. Two deficiencies may be noticed in the mechanism. Provision must be made that only one pupil key may be pressed at one time. This has already been solved in cash registers. It is desirable to have some method to set all the recorders at zero easily. This has been mastered in adding machines.

The cost of installation of such equipment would necessarily depend upon the demand. By comparison with current quotations on relays, switches of special design, etc., a rough estimate of five hundred dollars was reached. For a more elaborate machine the cost might amount to fifteen hundred dollars, especially if only a few were to be manufactured. These estimates do not include battery, lantern, screen or lights. They do include wire and a small amount of recorder forms. The cost of operation would not be excessive. The chief item would be current, which would compare with that of the use of any lantern.

Science Important to Empire, Prince of Wales Declares. In a message to the British Association for the Advancement of Science read at its inaugural meeting in Leeds, the Prince of Wales, in relinquishing the office of president of that body which he termed "so-called parliament of science," said:

"At Oxford last year I ventured in my address to lay before the meeting a view of the relations between science and the State. I felt subsequently some justification for having chosen this topic, when I observed in the proceedings of the Imperial and Colonial Conferences of the past year the extraordinary emphasis laid upon the value of scientific research in relation to imperial development. Both conferences set up special committees on research, and we cannot but believe and rejoice that the foundations of an imperial scientific service are being firmly laid."—*Science Service*

AN IMPROVED LECTURE-TABLE DEMONSTRATION OF IONIZATION AND CONDUCTIVITY

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Many textbooks describe lecture demonstrations to show the effect of dilution on the conductivity of electrolytes, most of them using a layer of sulfuric or acetic acid below a layer of water in a glass trough provided with electrodes.

By a very simple modification, we achieved a considerable improvement in this important demonstration, at least as evidenced by student interest and ability to answer questions concerning it. Using glacial acetic acid, we colored it a brilliant red with fuchsin. With the common set-up shown, the colored acid was allowed to run beneath the water. The students were fascinated to see the brilliant red layer approach and touch the electrodes. All but a few now expected the light to glow. This emphasized the idea that electrolytes must commonly be in solution before they ionize. Bringing the acid into solution by stirring the mixture caused the light to glow visibly. The addition of another liter of water, of course, caused a brighter glow, leading to a discussion of the maximum conductivity to be expected and the expression of ionization in terms of the conductivity ratio.

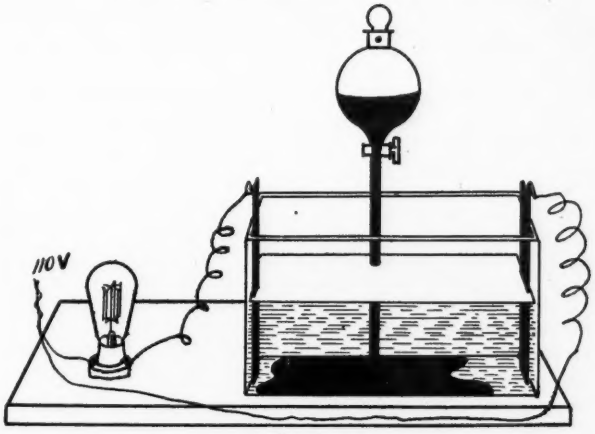

FIG. 1

The demonstration catches the eye of the student, with the brilliant color. With a white towel beneath the trough, a large class can follow the spread of the acid to the electrodes; furthermore, the use of an elec-

trolyte for which the law of mass action holds obviates any hesitation on the part of the instructor in speaking of the presence of unionized molecules of the acid in solution, and he may follow the classical theory of Arrhenius, *ad lib.*

Short Radio Waves Act Like Light. Exploring that region of radio waves so short that they approach the invisible heat and infra-red rays, engineers of the General Electric Company have discovered interesting and unexpected phenomena.

An experimental 5-meter radio sending set was recently put into operation at South Schenectady where the experimental radio work of the company is done. Previous tests with sending stations on 15 to 30 meters, wave-lengths far below those usually used in broadcasting, had caused the engineers to expect somewhat unusual results, such as complete fading close to the station and extremely satisfactory reception at extreme distances.

But in the preliminary tests with the 5-meter set, it was found that radio signals of that high frequency had a shadow effect very much like light. A small hill prevented reception in the valley beyond. To give the light-like radio waves as long a reach as possible the small transmitting set was hoisted to the top of two fifty-foot towers. Under these conditions it was possible to pick up the signals 32 miles away, using 60 watts power. All tests so far have been made during the day, but night tests with 500 watts power are scheduled. A receiving set for the short waves will be placed in the top of the Woolworth Building in New York City, some 135 miles away, in order to test further the properties of the 5-meter waves. This tall New York building was selected because maps show that there is an uninterrupted line of "vision" between it and the Schenectady sending set.

The experimental radio station, 2XAF, operating on a slightly longer wave-length, 32.77 meters, has been heard all over the world. Using an antenna only 25 feet long it has been picked up and rebroadcast in Australia. One peculiarity of this sort of radio wave is that it skips over considerable distances, being inaudible, for instance, between 10 and 1000 miles from the station.—*Science Service*

Gas Speeds Growth of Plants. Ethylene, one of the ingredients of common illuminating gas, is working a revolution in the fruit and vegetable industries. Poisonous to plants when present in high concentrations, in small quantities it acts as a stimulant, and advantage is being taken of this recently discovered fact. Dr. F. E. Denny of the Boyce Thompson Institute, Yonkers, N. Y., discussed fruit ripening by gas before the recent meeting of the American Chemical Society.

It had long been known that, when the rooms where citrus fruits were stored were heated with kerosene stoves, the usual time required for changing the green rind to the desired golden hue was reduced to about one-fourth. Dr. Denny's experiments in 1922–23 indicated that the active agent in the combustion gases was ethylene. Now this gas is used instead of the old oil stove in the treatment of hundreds of carloads of oranges and lemons, thus avoiding fire risk and smoky odor. Dr. Denny said today:

"Surprisingly low concentrations of ethylene added to the air surrounding the fruit are able to bring about hastened coloration. If precautions are taken to prevent the loss of ethylene by diffusion, the process is successful with 1 part ethylene to 10,000 parts of air, 1 part in 100,000, or even 1 part in 1,000,000. In practical operation a somewhat higher original concentration is used in order to take care of losses of gas, but it has not been necessary to use a greater concentration than about 1 cubic foot of ethylene to about 5000 cubic feet of air."—*Science Service*

REPORT OF THE EXECUTIVE COMMITTEE OF THE A. C. S. ON THE PROPOSED INSTITUTE FOR CHEMICAL EDUCATION

At the Richmond meeting the Council referred to the Executive Committee for consideration and report the recommendation of the Committee on Chemical Education that there be approved an Institute for Chemical Education. Although the resolution specifies that in all financial details such an Institute shall be subject to final approval by the Directors and in other matters to the approval of the Executive Committee or the Council the committee feels that, as referred to it, details concerning such an Institute are as yet too nebulous to enable intelligent action to be taken. While it is understood that the discussion of such a research institute, both in the Senate of Chemical Education and in the Committee on Chemical Education, centered around the tentative plan published in the JOURNAL OF CHEMICAL EDUCATION in January, 1927,[1] it has been stated in conversation by several members of the Senate and of the Committee, that there is a lack of agreement with respect to the plan published. However, resulting discussion has brought forward several points worthy of further consideration.

Therefore, while the Executive Committee feels that the matter is not in a form sufficiently definite to enable it to give either a negative or affirmative answer, it has seemed best to present in this report to the Council a suggestion for the initiation of work in which we are all interested, with the recommendation that the Committee on Chemical Education give it careful study and consideration, with the hope that from it will come a more definite plan upon which the Council and the Directors can take action.

In common with the teaching of other subjects, instruction in chemistry involves content and method. As compared with other subjects, particularly other sciences, the content of chemistry would seem to differ from them more than the method of teaching and since it is always wise to initiate new enterprises with ample caution, the committee feels the Society would only be justified in centering its attention on the content phase of the problem.

Just as it is recognized that accounts of progress in the field of chemistry must be interpreted to the lay public and to the chemists themselves if their work chances to fall outside the given specialty, so it must be recognized that this material seldom appears in a form which makes it easy for the busy teacher, particularly in high and secondary schools, to assimilate it and further interpret it to classes. Even if originally presented in a form suitable for such use, there is generally a considerable period during which authorities disagree and the teacher is at a loss to know which point

[1] See THIS JOURNAL, **4**, 110–4 (Jan., 1927).

of view is accepted by the majority of those competent to judge. It is also true that many secondary school teachers have little time in which to read sufficiently widely or to attend the scientific meetings necessary to maintain a broad view of chemistry as it develops, and they gradually become less efficient in the presentation of the subject to succeeding classes.

It is felt, therefore, that some agency which might be styled, for example, Bureau for Promotion of Chemical Education, might be established primarily for the purpose of presenting in a form most useful to teachers those new theories, principles, and results of investigations upon which there is a fair consensus of opinion, summaries of the status of advance in special lines of chemistry, and specially prepared accounts of the latest discoveries considered either as a matter of information or of subject material for teaching purposes.

The committee feels that in initiating such work, the expense incident to the establishment of a particular center or the erection of a special building should be avoided, but that if sufficient funds can be made available someone should be selected as a manager for this activity, his principal duty being to ascertain those who have been most successful in doing the particular bit of work that needs to be done at the moment, securing this coöperation, allocating the work, correlating the results, and devising the best means of placing such results in the hands of teachers. He should also devise means for encouraging teachers to utilize this material, and inaugurate a follow-up system whereby it could be ascertained how widely the material is being used and whether the results seem to indicate that the right procedure is being followed.

The committee also feels that rather than risk the permanent employment of a small group of men for this work, it would be wiser, especially in the initial stages of such activity, funds being available, to arrange for the retaining of well-known talent on a temporary basis, permitting them to conduct their part of the work in their present locations and providing funds for such necessary travel as might be involved in arranging the material assigned to them. For example, let us suppose Professor A has demonstrated his ability as a teacher in colloid chemistry. If funds were available, the manager would approach Professor A to bring together in a form believed suitable for the teacher all of the material in some field of colloid chemistry and would arrange with his college or university for the services of Professor A, taking over all or such part of the salary obligations as circumstances might dictate. At the close of the work Professor A would take up his full teaching or other duties at his accustomed post. In this fashion the services of a large number of well-qualified men could be obtained without running the risk of choosing the wrong men in the beginning, and in time certain men would prove so adept in work of the kind that wisdom might indicate their employment on a full-time

basis for the Bureau. A valuable by-product would be the creation of a number of widely scattered centers of interest in this work.

The method of publishing and placing this specially prepared material in the hands of the teachers would have to depend upon circumstances. Conceivably existing mediums of publication like the JOURNAL OF CHEMICAL EDUCATION would present one of the best methods for disseminating this material. Reprints, pamphlets, and monographs offer other methods.

Unquestionably teachers profit greatly from a multiplication of contacts and the less experienced teachers can be greatly helped by demonstrations of method. We, therefore, suggest for further consideration a proposal whereby certain teachers who have made a brilliant success at their work can be brought in contact with larger groups of teachers. It might be feasible to hold at irregular intervals state or regional meetings of chemistry teachers at which lectures and demonstrations involving the method of teaching would be given over a week-end period. On such occasions educators should be provided to discourse on methods of teaching, teachers could give demonstration lectures with experiments, with motion pictures, and with other aids to teaching, and a helpful part of such a program would be an open forum on some selected topic. While the appearance of such teachers before actual classes might be very helpful, these appearances should take the form of special lectures to the class rather than a demonstration of methods of teaching, for if the latter were done the regular teacher might be caused some embarrassment and conceivably suffer from comparisons that would be made by the pupils between the special and the regular class sessions. However, details of any demonstration must obviously be left for future consideration.

To encourage and indeed to insure attendance upon such meetings of teachers, funds might be wisely expended in meeting, say, one-half the actual travel expense of teachers who under such circumstances could probably obtain a part or all of the remainder from their school boards or others in authority. Should this prove too great a burden, it is possible that such expenditure could be limited to those especially invited, not because they can contribute much but because they really need experience, or it might be limited to those below a certain predetermined salary level.

Such meetings would not only insure better contact between teachers of the area but would bring them in contact with these specialists, who in turn could advise the director of the Bureau of conditions found, of the reaction to the work being done, of new problems requiring consideration, etc., etc. Obviously the Bureau would arrange such meetings, tours of the teachers selected, and other details.

As for research in the methods of teaching, it would seem possible that this could be given some attention without involving the Society in research in the field of pedagogy. The various schools of education are

at work in this field and it might be useful to summarize and correlate their findings and advice, but since it seems evident that the best research in methods of teaching chemistry is actually going on in the class-rooms of all successful, inspiring, and keen teachers, the first steps that might be taken under this Bureau for the extension of chemical education would be to secure and publish descriptions of the methods employed in those schools where the results with students indicate the success of the method.

It would seem highly desirable, indeed necessary, for the Committee on Chemical Education to seek the advice of the most successful teachers of chemistry as to the present needs in teaching, considering the problem from the viewpoint of secondary schools and of institutions of higher learning. In a matter of such import it is very needful to have the advice of competent persons not interested in the exploitation of any particular idea.

The committee offers the above suggestions to the council for reference to the Committee on Chemical Education, in the belief that a plan somewhat as outlined would avoid many of the errors that might be made in initiating a more ambitious project requiring far greater funds. It would postpone for some time decision as to whether or not the Bureau as a whole need have a definite location, and such a plan would provide both the means and the time for the selection of such small staff as might ultimately prove desirable to carry on such work as the Bureau might ultimately perform with the greatest success for the extension of chemical education.

CHARLES L. PARSONS

Automotive Industry Depends Much on Grinding Machinery. The single general-purpose emery wheel of the old-fashioned machine shop would be amazed—supposing it had a consciousness—if it could come back and see the family of abrasive machinery that has taken its place in the modern monster automobile factories. Not only have the new grinders new shapes and uses, but they are made of new materials, born of the electric furnace. At the recent meeting of the American Chemical Society in Detroit, Dr. Lowell H. Milligan of Worcester, Mass., told his colleagues of the importance of abrasives in literally grinding out automobiles.

"It has been said that a Ford manufactured by former methods would cost as much as a Rolls Royce does now, were it not for grinding," Dr. Milligan stated. In 1904 there was not one grinding machine in the automobile industry. Today there are 68,000. Countless parts of an automobile are finished by grinding. The chemists and metallurgists have been continually making tougher and harder steels which cannot be satisfactorily machined, but must be shaped by grinding.

"Abrasives are of service not alone as grinding wheels. Loose abrasives are used, suspended in grease or water, for grinding valves, for lapping piston pins and rings, crankshaft pins and bearings, and for surfacing plate glass.

"Glued on the surface of polishing wheels, abrasives serve to smooth and polish radiators, fenders, bumpers, and many other metal parts. Fine abrasives cemented on paper or cloth are used for various finishing operations, conspicuous among which is the smoothing and surfacing of lacquers on automobile bodies."—*Science Service*

DOCTORATES IN CHEMISTRY CONFERRED BY AMERICAN UNIVERSITIES, 1926–1927

COMPILED BY CALLIE HULL AND CLARENCE J. WEST, RESEARCH INFORMATION SERVICE, NATIONAL RESEARCH COUNCIL, WASHINGTON, D. C.

Continuing the compilation which has appeared in THIS JOURNAL for the past two years (**3,** 77–99 (1926); **4,** 99–109 (1927)), the Research Information Service of the National Research Council offers the following statistics of doctorates in chemistry conferred by American universities during the academic year 1926–1927.

A few changes appear in the totals of Table I, owing to the addition of two or three institutions which have reported the granting of doctorates during the years covered. Two universities, California and Pittsburgh, are listed in Table II as conferring 10 or more doctorates in 1926–1927 which did not appear in the group last year, while two more, Michigan and Iowa, are dropped from the list during this period.

TABLE I

DISTRIBUTION OF DOCTORATES IN CHEMISTRY BY UNIVERSITY, BY YEAR

	'19–'20	'20–'21	'21–'22	'22–'23	'23–'24	'24–'25	'25–'26	'26–'27
American	..	..	..	..	..	..	1	1
Boston	..	..	..	1	..	..	1	..
Brown	1	1	..	..	..	5	2	2
Bryn Mawr	..	..	1	..	..	..	..	1
California	3	6	8	11	6	8	7	16
Calif. Inst. Tech	1	..	2	..	3	4	7	..
Catholic	..	..	..	1	2	2	1	3
Chicago	13	16	14	12	19	14	26	21
Cincinnati	1	2	3	1	2	4	4	3
Clark	2	3	2	3	3	..	..	..
Colorado	..	..	1	1	..	1	2	1
Columbia	8	18	13	28	35	30	34	28
Cornell	3	8	9	8	19	14	12	16
Fordham	1	..	2	2	..	2	2	1
George Washington	3	1	..	6	3	1	2	2
Harvard	4	5	3	5	18	13	10	11
Illinois	8	7	16	19	19	18	18	11
Indiana	..	..	1	2	1	2	2	2
Iowa	..	..	..	4	3	6	10	9
Iowa State	..	..	..	..	4	7	8	7
Johns Hopkins	10	10	13	12	12	10	19	15
Kansas	..	..	..	..	1	3	1	5
Maryland	..	..	..	..	..	..	4	2
Mass. Agr. Coll	..	..	..	1	..	..	..	..
Mass. Inst. Tech	4	6	5	6	11	17	8	6
Michigan	2	6	5	2	11	2	13	8
Mich. State Coll	..	..	..	..	..	..	1	..

Minnesota	..	..	5	3	9	8	8	8
Missouri	..	..	..	..	1	1	1	1
Nebraska	..	1	1	1	3	3	1	1
New York	1	3	1	6	1	3	2	3
North Carolina	..	2	1	1	..	..	5	2
Northwestern	..	..	4	..	4	1	1	3
Notre Dame	1	..	..	1	2	..	..	..
Ohio State	2	5	4	13	14	23	11	15
Pennsylvania	..	1	3	..	4	1	7	7
Pittsburgh	1	2	5	6	5	7	3	10
Princeton	3	5	5	2	8	4	4	4
Radcliffe	..	1	..	..	..	..	..	..
Rice	..	1	..	..	..	1	..	1
St. Louis Univ	..	..	..	..	..	..	..	2
Stanford	..	2	1	3	8	2	5	3
Syracuse	..	..	..	..	..	..	..	2
Tulane	..	..	..	..	..	..	..	1
Virginia	1	..	1	1	2	3	2	3
Wash. Univ., St. L.	..	..	..	1	..	..	..	2
Washington	..	1	2	..	1	2	..	1
Wisconsin	8	9	13	14	21	26	24	16
Yale	12	13	13	17	8	16	18	12
TOTAL	93	135	157	194	263	264	287	268

TABLE II

UNIVERSITIES GRANTING 10 OR MORE DOCTORATES IN CHEMISTRY, 1926–27

	'19–'20	'20–'21	'21–'22	'22–'23	'23–'24	'24–'25	'25–'26	'26–'27
Columbia	8	18	13	28	35	30	34	28
Chicago	13	16	14	12	19	14	26	21
California	3	6	8	11	6	8	7	16
Cornell	3	8	9	8	19	14	12	16
Wisconsin	8	9	13	14	21	26	24	16
Johns Hopkins	10	10	13	12	12	10	19	15
Ohio State	2	5	4	13	14	23	11	15
Yale	12	13	13	17	8	16	18	12
Harvard	4	5	3	5	18	13	10	11
Illinois	8	7	16	19	19	18	18	11
Pittsburgh	1	2	5	6	5	7	3	10

American

Raymond Clifford Wiley, "The so-called absorption of the calcium ion by the hydroxides of iron and aluminum."

Brown

Earl Henderson Brown, "The properties of boron trifluoride in relation to ammonia and various amines." Arthur Morrill Neal, "Studies relating to methyl tin derivatives."

Bryn Mawr

Marion A. Ames, "An electrochemical comparison of certain cyclic nuclei."

California

John Geldart Aston, "The base strength of the α-alkoxyl amines; the effect of oxygen on the basicity of amines. The α-alkoxyl quaternary ammonium compounds; the decomposition of quaternary ammonium bases." Henry Edward Bent, "The vapor pressure of sodium and cesium amalgams." Dean Burk, "Photosynthesis with ammonia." Lelia Margaret Chapman, "Studies on the nature of the combination between dyes and proteins." John Chipman, Jr., "The Soret effect; partial molal entropies." Crawford Fairbanks Failey, "The activity coefficients of undissociated monochloro- and dichloroacetic acids in aqueous salt solutions; the activity coefficients of non-electrolytes in aqueous salt solutions." Mikkel Frandsen, "The electromotive behavior of iron hydroxides and iron." Harper Wine Frantz, "A study of the internal pressures of some organic liquids and liquid mixtures." Simon Freed, "The magnetic susceptibilities of the ions of vanadium." Joseph Olney Halford, "Equilibria involving the complex ions of silver; the free energy of some silver compounds." Cecil Theodore Langford, "The activity coefficient of sulfuric acid in aqueous sodium sulfate solutions; the free energies of some mercury compounds." Homer Louis Robson, "The system: $MgSO_4$–H_2O from 68° to 240°." Anthony Joseph Salle, "The metabolism of *Leishmania tropica*." Gordon N. Scott, "The conductivity, freezing point lowering and activity coefficient of aqueous barium nitrate, sodium sulfate, and sulfuric acid." Francis Edward Smith, "The synthesis of water over nickel and copper catalysts; the mixture effect and promoter action." Laurence John Hartley Teakle, "Phosphate in the soil solution as affected by reaction and cation concentrations; with a supplementary study on absorption of phosphate by plants in soils and in culture solutions."

Catholic

Aloysius John Burggraff, "The adsorption of sulfur dioxide by titania gel." Julitta Larkin, "Hydration in liquid-protein systems." Pauline Wright, "Hydration in liquid-protein systems."

Chicago

Langston Fairchild Bate, "Pseudo-thiohydantoins from some higher fatty acids." Ko Chung Chen, "The effect of electrical potential on the optical rotation of betaines; preparation of derivatives of α-trimethyl-ammonium-propionate and ε-trimethyl-ammonium-β,ξ-dimethyl-octoate; and determination of basic constant of alpha and epsilon betaines." Mabelle Crystale Dame, "The preparation and the rearrangement of phenyldibiphenylmethylchloroamines. An attempt to effect rearrangement of triphenyl-methyl-β-methylhydroxylamine by heat." Beals Ensign Litchfield French, "Studies on the purification and properties of calves' rennin." Joseph Solomon Friedman, "The mercuration of nile blue." Paul Luther Karl Gross, "The geometry of atomic collision photography. The determination of a standard for surface tension measurements. Pendent drops." Elbert Dung Wui Ho, "The action of phenylhydrazine upon bromohydrouracil—an attempt to prepare 5-aminohydrouracil." Perry Yates Jackson, "A study of the chlorination of acetanilide." Grant Melvin Kloster, "Studies of the effect of varying hydrogen ion concentration upon the activation, destruction, and rate of action of proteolytic enzymes in gastric mucous membranes." Marguerite Genevieve Mallon, "Metabolism experiment on the adult albino rat fed once a day; observations on calcium metabolism." Harold Lawrence Mason, "A study of tautomeric

chloroindophenols: a contribution to the theory of color production in dyes." Clemmy Olin Miller, "The asymmetry of certain hypnotics and its relationship to physiological behavior." Bernard Radcliffe Mortimer, "A further separation of the isotopes of mercury by evaporation and diffusion." Irving Elkin Muskat, "The mechanism of substitution in the aromatic nucleus: direct addition in the benzene ring." Casper Irving Nelson, "The intracellular proteins of bacteria: I. Globulins. II. The globulins as indicators of interspecies relationship." Esme Eugene Rosaire, "Conductivity measurements at audio and intermediate frequencies." Walter Charles Russell, "The electromerism of bromine chloride. The reaction of a bromine chlorine mixture with diphenyl-ketene." Edna Helen Shaver, "The catalytic reduction of the aldonic acids to aldoses." Alice Caroline Willard, "A comparison of evaporated with pasteurized milk as a source of calcium, phosphorus, and nitrogen." Delbert Edmund Wobbe, "The thermal decomposition of anhydrous oxalic acid and its relation to the photochemical decomposition." Tsoh Wu Zee, "New methods of preparation of phenylethyl malonic methyl ester. Sodium salts of aromatic nitrils."

Cincinnati

Byron Curtis Brunstetter, "A comparison of the blood-coagulation mechanism with the immune hemolytic mechanism." Emmett Bryan Carmichael, "Ricin, its nature and action." Arthur Rose, "A study of the compounds obtained by reducing action of metals upon salts in liquid ammonia."

Colorado

Pleasant Ernest Roller, "The Cannizaro reaction of furfural."

Columbia

Mildred Adams, "A quantitative comparison of the influence of neutral salts on the activity of pancreatic amylase and some of the factors involved." Roger William Allen, "New isomers of dehydrothio-*p*-toluidine. Further relationships between chemical constitution and color among thiazole dyes." Yao Chun Cheng, "Practical limitations in the use of sodium hydroxide solutions for extraction of tar acids from low temperature coal tars." Bernard Burrell Coyne, "Syringic acid derivatives: aminosyringic acid and other substitution products." Ray H. Crist, "The photochemical decomposition of potassium persulfate." William F. Ehret, "A study of compound formation in systems of two salts with a common ion in aqueous solution." Frank Rose Elder, "Synthesis of 6-hydroxypiperonylic acid and some related compounds." Olga Helen Marie Gloy, "Vitamin B determination and requirement with special reference to protein intake." David Mathews Grayzel, "The hydrogen ion concentration of the intestinal contents under various conditions, with special reference to rickets." Herbert Ludwig Jacob Haller, "The configurational relationships of 2-hydroxy, 3-hydroxy, and 4-hydroxy acids." Edna R. Hamburger, "A study of ferric oxybromide hydrosols." Margaret Constance Hessler, "Experiments upon the quantitative differentiation of vitamins A and D." Alma Elizabeth Hiller, "The effect of histamine on protein catabolism and on acid-base balance." Henry Price Howells, "A contribution to the solution of the 'Pechmann dyes' problem: the chemistry of acyl paraquinones." Thomas Robert LeCompte, "The so-called adsorption of ferric oxide hydrosol by charcoal." Zanvil Charles Loebel, "The behavior of deaminized gelatin." Fred Carleton Mabee, "A study of ferric oxyacetate hydrosols, or the preparation and aging of ferric oxyacetate hydrosols, and the application of the quinhydrone electrode to the measurement of pH of iron sols." Eugene Miller McColm, "Researches in quinazolines: The preparation of some new analogs of cinchophen." Paul DeVries Manning, "The genesis

of oil shale and its relation to petroleum and other fuels." Edward H. Miller, "Influence of hydrogen ion activity upon the stability of vitamin A." Harold H. Parker, "Some fundamental problems of an American shale industry." Julius Sendroy, Jr., "The solubility of calcium salts." Allan Kay Smith, "The rate of interdiffusion of sodium hydroxide and hydrochloric acid by a calorimetric method." Walter Herron John Taylor, "The synthesis of certain new derivatives of phenacetin." Martha L. Washburn, "The hydrolysis of cane sugar by invertase in the presence of potassium chloride." James Herbert Werntz, "Studies of the corn amyloses. Properties of corn alpha amylose." Norman E. Woldman, "The refining of the lower fractions of shale oil by liquid sulfur dioxide." Winifred J. Wood, "Studies in the velocity of inactivation of malt amylase."

Cornell

Felipe Tiongson Adriano, "Some chemical studies on the treatment and disposal of dairy wastes." George Monroe Bateman, "A study of the apparent viscosity of skim milk and of cream as influenced by various physical factors." Irving Tracy Beach, "2,7-dimethyl-sulfonefluoran, 2′-hydroxy-5′-methylbenzoyl-2-benzene sulfonic acid and some of their derivatives." Harold Arthur Bedient, "A study of uranyl acetate as a reagent in microscopic qualitative analysis." Frederick Mason Brewer, "Germanium dihalides." Yan Tsz Chiu, "Studies of the physical and chemical properties of soya bean milk." William Howlett Gardner, "Some reactions of azido-carbondisulfide; reactions with the halogens." Ernest Jacob Joss, "The action of metals on nitric acid." Albert Washington Laubengayer, "Some germanium glasses." Isaac Neuwirth, "The problem of sugar in normal urine." Chia Lin Shao, "Studies in chemical spectroscopy." Charles William Stillwell, "The color of the ruby." Katherina Marjorie Tressler, "Metallic germanium; the preparation of the metal and a study of some of its physical and chemical properties." Carl William Tucker, "A study of photovoltaic cells." Randall Whitaker, "A study of rennet coagulation using the hydrogen and sodium electrodes for determining changes in ion concentration." Mary Louisa Willard, "Hydroxyhydroquinol-sulfonephthalein, the intermediate acid, 2′,4′,5′-trihydroxybenzoylbenzene-2-sulfonic acid and some of their derivatives."

Fordham

Walter A. Hynes, "Investigations on the action of glucose as a reducing agent for aromatic nitro-compounds."

George Washington

Joseph Charles Murphy, "The optical rotation of proteins." Colin Whittaker, "Glaucosil."

Harvard

William Moore Craig, "A revision of the atomic weight of gallium." Benjamin St. John Garvey, "Studies in the bixanthyl series. Platinum oxide platinum black as a catalyst in the reduction of organic compounds. The reduction of unsaturated aldehydes." Philip Albert Leighton, "Electrolysis under intense illumination. Relationships involving pressure, mercury transfer, and other variables in mercury vapor arcs. The photolysis of quinone in monochromatic light." Erik Harry Lundin, "Intermediary carbohydrate metabolism. On the determination of sugar in biological fluids. Some factors influencing the capacity to perform muscular work." Harry Henry Powers, "A study of the organic phosphorus compounds of muscle." Malcolm Field Pratt, "An electrochemical study of the reduction of certain hydroxy-azo dyes. Certain addition reactions of dibenzoyl-ethylene." George Hugh Reid, "Glutaconic

acid. 5,6-diphenyl-3-*p*-chlorphenyl-4-keto-$\Delta^{5,6}$-orthoxazine." Nelson Kellogg Richtmyer, "The reaction between isoxozoline oxides and organic magnesium compounds." Roger Greenleaf Stevens, "Researches on the cobalt and chromium amines." Charles Edwin Teeter, Jr., "A contribution to the study of the system cadmium-mercury. On kinetic salt effect." John Crawford Woodhouse, "Adsorption by dehydrated crystalline substances."

Illinois

Dorothy Emma Bateman, "The stability of hexa-substituted ethanes. The nitration of some derivatives of cymene." Arthur Evan Boss, "Observations on the rare earths: the atomic weight of erbium." Merlin Martin Brubaker, "Structure of opianic acid condensation products. Structure of diphenyl benzene derivatives." William Edward Bunney, "The nutritive value of arginine, glutamic acid and proline." Alden Williams Coffman, "The surface tension of metals with reference to soldering conditions." J. Harvey Kleinheksel, "Observations on the rare earths: the preparation and properties of some anhydrous rare earth chlorides." John Clarke Michalek, "The vapor pressure and vapor density of dry ammonium chloride." James Winfred Neckers, "Observations on the rare earths: Fractional precipitation of cerium group earths by electrolysis. Solubility of rare earth oxalates in nitric acid. Separation of cerium." Edward Graffam Partridge, "Conductivity of solid salts." John Merriam Peterson, "Freezing points of benzene solutions." Lloyd Thompson Sandborn, "Synthesis in the pyridine-piperidine series. The structure of the compounds produced by the addition of mercuric salts to olefins."

Indiana

Gastao Etzel, "Catalytic activity of titania on the production of nitro compounds." Worth Albert Fletcher, "Concerning the use of nitro compounds as oxidizing agents."

Iowa

Dionisio Martinez Birosel, "The behavior of certain mixed ethers toward bromine and hydrogen bromide. Compounds of alkali metals and mixed ethers containing isoalkyl radicals." Bozetech Chestmir Bren, "The reduction of 2,5-dibromonitrobenzene and its derivatives with different reducing agents." Henry Fraser Johnstone, "The absorption of the vapors of methane and of its chlorine derivatives by activated charcoal." Elizabeth Julia Magers, "A study of the fifty gram glucose tolerance test with reference to sugar and mineral changes in blood and urine." Frederick C. Mortensen, "The behavior of some cycloparaffin derivatives in certain molecular rearrangements." Alfred Clarence Nelson, "The influence of solvent on the photochemical decomposition of trichloroacetic acid." Charles Nelson Ott, "A study of the mechanism of the catalytic decomposition of esters by nickel." Murray John Rice, "Adsorption of water, ethyl alcohol, acetic acid and ethyl acetate vapors by metallic oxides: its bearing on heterogeneous catalyses." Robert Dewey Snow, "An improved dynamic method of measuring vapor pressures."

Iowa State College

Buford H. Butcher, "Study of the metabolism of *Bacterium coscoroba* on gluconic acid." Leo Martin Christensen, "The fixation of atmospheric nitrogen by yeast." Harold Williams Coles, "Laboratory synthesis and the digestion by microörganisms of certain modified sugars." Roy McCracken, "The replacement of costly and inflammable ether by other solvents. The reaction between nitro-compounds (including war gases and explosives) and organo-magnesium halides." Everett E. Peterson, "A study of the preparation of sugar sirups." Joseph Bradley Quig, "The preparation and reac-

tions of the lower chlorides and oxychlorides of silicon." Anderson Wheeler Ralston, "Thiohydrolysis in solutions in liquid hydrogen sulfide."

Johns Hopkins

John T. Chappell, "Thermal decomposition of ozone. Ethyl acetate equilibrium in the vapor phase." Russell Drew Drinkard, "Vapor pressure of alcoholic soap solutions at elevated temperatures." Fitzgerald Dunning, "Organic compounds of antimony." Howard Wilmot Estill, "Chemical studies directed toward the isolation of the fat-soluble vitamins A, D, and E." Thomas Huger Hazlehurst, Jr., "A study of the reaction between mercuric chloride and ammonium oxalate." Marinus Cornelis Kik, "The nutritive value of haddock and herring (*Clupea harengus*)." Robert Myers McKinney, "Direct measurement of the osmotic pressure of electrolytes." Edward Fortune Milan, "The physical chemical study of vanadium pentoxide." Henrietta Morris, "A study of the possibilities of modifying the composition of milk proteins by diet." Howard William Post, "Nitration of substituted anilines." Richard Irwin Rush, "A study of the structural changes in amorphous materials." Hugh Molleson Smallwood, "An attempt to prepare triatomic hydrogen. The determination of monatomic hydrogen and some of its chemical properties." Harry Edward Smith, "Studies in the thickness of adsorbed vapor films." Ume Tange, "The preparation and properties of the alophanates of certain sterols." Robert Vose Townend, "A new method for studying the osmotic pressure of solutions."

Kansas

Selma Gottlieb, "An irreversible hydrocarbon cell." Henry Johnson Long, "Synthesis and properties of the possible isomeric mono-chloro, mono-iodo toluenes." Harvey Vernon Moyer, "The replaceability of certain methylene groups and the relation of constitution to the stability of the C-C linkage." Chester Merle Suter, "Reaction of aromatic nitro compounds with alcoholates." Mary Elvira Weeks, "The rôle of hydrogen ion concentration in the precipitation of calcium and magnesium carbonates."

Maryland

E. G. Vanden Bosche, "The potential of the nickel electrode." A. L. Flenner, "The relative electronegativity of organic radicals and its use in interpreting certain organic reactions."

Massachusetts Institute of Technology

Bernhardt Joseph Eiseman, Jr., "Upon the absorption spectra of several gases at high concentration, with particular reference to molecular aggregation and polymerization." Ernest Hamlin Huntress, "The Beckmann rearrangement of fluorenone oxime and of 2-nitrofluorenone oxime." Robert Watkeys Mitchell, "The electrochemical oxidation of toluene." Melvin Alfred Perkins, "Some 9-aryl uric acid derivatives; their synthesis, properties and behavior toward hydrogen peroxide." Helmuth Gustav Richard Schneider, "The action of aluminum chloride on hexane and isohexane and the application of the Friedel-Crafts reaction to paraffin hydrocarbons." George Raymond Tucker, "The constitution of certain sulfonic acids and conditions affecting the replacement of their sulfonic groups by hydrogen in reduction."

Michigan

Lee Owen Case, "A study of the Wheatstone bridge method for the measurement of electrolytic conduction." Frank Weldon Hightower, "A study of the catalytic con-

version of blue water gas to a gas of high methane content." Margaret Newell Woodwell Johnston, "A comparative study of the rate of metabolism of certain amino acids." George Truman Lewis, "The utilization of some organic derivatives containing sulfur and of elementary sulfur by the organism of the white rat." J. W. Hollywood Monaweck, "The mechanism of gas absorption." Harold Judson Osterhof, "The measurement of adhesion tension solid-liquid." Robert Freeborn Ruthruff, "*m*-Substituted biphenyl derivatives and some triarylmethyls with *m*-substituted phenyl groups." Olive May Searle, "Metabolism in psychoses. Fasting blood sugar and glucose tolerance."

Minnesota

David Reuben Briggs, "The determination of the zeta-potential on cellulose, a method." Donald Edwards Edgar, "Carbon tetrabromide as a brominating agent." Kurt Walter Franke, "Measurement of H-ion concentrations in the control of pulp and paper manufacture." Raymond Leslie Gregory, "A study of the quantitative determination of bile salts." Sigfred Melanchton Hauge, "Studies in adsorption with carbons." Ralph Kenneth Larmour, "A comparative study of glutelins of the cereal grains." James Leonard St. John, "The colloidal behavior of dough and the properties of bread as influenced by dry skim milk." William Martin Sandstrom, "Studies on some globulins and deamidized proteins."

Missouri

Hannah Stillman Bradfield, "Relation of surface area to metabolism."

Nebraska

Ralph Frederick Nielsen, "The free energy of cupric chloride."

New York

Leslie Randolph Bacon, "A phase rule study of sodium carbonate, sodium bicarbonate and water as a three component system." Charles Francis Pickett, "The decomposition of hydrogen sulfide." Sterling Bishop Smith, "Equilibrium in the quaternary system, sodium carbonate, potassium bicarbonate and water at 25° Centigrade."

North Carolina

Boyce Galloway Carson, "Bromination of naphthazarine." Lillie Fielding Poisson Cutlar, "New derivatives of 2-amino-5-bromo-*p*-cymene."

Northwestern

Arthur Lawrence Fox, "The mercuration of naphthoic acids and derivatives of naphthoic acids." Ernest Bowman Kester, "Organic compounds of arsenic." Melville Lawrence Wolfrom, "Action of dilute alkali on tetramethylglucose."

Ohio State

Marvin Achterhof, "The mechanism by which diphenylguanidine functions as an accelerator in the vulcanization of rubber." Harold James Barrett, "The conversion of fumaric and maleic acids into tartaric acid." George Wayland Bennett, "A study of adsorption at the solution crystal interface." Henry Clyde Carlton, "Determination of the size and shape of some organic molecules by a diffusion method." William Robert Cornthwaite, "The action of potassium hydroxide on dihydroxy acetone." Harry Ben Dykstra, "The use of β-halogen substituted ethers in the synthesis of un-

saturated compounds." Ralph Holmes Ferguson, "The effect of temperature and alkali upon the permanganate-manganate reaction." Robert Franklin Heald, "Metallic tantalum as an electrode material." Charles Henry Hunt, "A study of the influence of fertilizers on the vitamin B content of wheat." James Edwin Hutchman, "The action of potassium hydroxide on fructose and glycolaldehyde." Ruth Frances Johnstin, "Calcium-pectin equilibrium in pectin-water soils." Frank Gilbert Keenen, "A study of the crystal growth of potassium alum in the presence of dyes." Warren Alvin Kramer, "The catalytic oxidation of carbon." Toh Liu, "A study upon starch." George Henry VanderBorgh, "The location and nature of ash in sugar."

Pennsylvania

Allan Russel Day, "Unification of bromination methods of analysis as applied to phenols and aromatic amines." Charles Clement French, "The effect of neutral salts on certain catalytic decompositions." Arthur Kenneth Graham, "A study of the influence of variables on the structure of electrodeposited copper." John Erskine Hawkins, "Hydrolysis of esters in weak acid-neutral salt solutions." Russell Pearce Heuer, "The effect of iron and oxygen on the electrical conductivity of copper." Eugene Reynolds Manning, "Hydrolysis of ethyl acetate in salt solutions of trichloroacetic acid." Nicol Hamilton Smith, "The atomic weight of scandium."

Pittsburgh

Wilmer E. Baldwin, "The action of ozone on the leuco-base of malachite green." John Ferguson Conn, "The electrolytic oxidation of *p*-bromotoluene and *o*-nitrotoluene." Carl Chambers Kesler, "Purification of abietic acid from rosin and preparation of some of its derivatives." Rachel Hoyle Kesler, "Derivatives of α-hydroxy-β-naphthoic acid." Catherine May Moore, "The study of the electrolytic oxidation of isoeugenol and acetylisoeugenol." Latimer Duffield Myers, "The application of the solid solution theory to the 'sweating process' of paraffin wax." William Lionel Nelson, "The bromination and chlorination of H-acid and chromotropic acid." Abraham Louis Robinson, "The solubility of potassium bromide in acetone as related to the inter-ionic attraction theory." Ralph Barth Trusler, "Amides and amide acid sulfates from nitriles and esterification of amide acid sulfates." John Leslie Young, "The effect of suspended material upon the electrical conductivity of aqueous solutions of slightly soluble salts."

Princeton

John Reginald Bates, "Studies in photosensitization." Charles Leslie Fleece, "The reactivity of halogenated ethers." Randolph Thomas Major, "Substituted *O*-alkyl hydroxylamines chemically related to medicinally valuable amines." John Philip Mason, "The rearrangement of acid azides and hydroxamic acids of geometrical isomers."

Rice

Everett Ellis Porter, "Physical chemistry of color-lake formation."

St. Louis

Charles Neal Jordan, "A micro-chemical study of an ovarian hormone." James Owen Ralls, "Preparation and standardization of active follicular hormone extracts and some properties of the hormone; preliminary report on the effect of the follicular hormone on basal metabolism."

Stanford

Elton Fred Cornell, "Ammonia analogs of carboxylic acids." Charles Vinton Hart, "Structure of so-called cyanogen azide and other derivatives of hydrazoic acid." Harold Henry Strain, "Ammono aldehydes and ketones."

Syracuse

Louis Cleveland Jordy, "The atomic weight of carbon through the carbon-chlorine ratio." Aden Jackson King, "A study of the alloys of barium."

Tulane

Arthur Ordway Kastler, "Studies in phosphate metabolism."

Virginia

Harold Bertrand Friedman, "The catalytic synthesis of water vapor in the presence of nickel oxide." Carroll Wardlaw Griffin, "The catalytic action of copper in the hydrogenation of ethylene." Edwin Carlyle Markham, "The reduction kinetics of copper oxide."

Washington Univ., St. Louis

Margherita Cotonio, "The mechanism of lactic acid formation in muscle tissue." Paul William Otto Preisler, "Electrometric reduction potentials of sugars."

Washington

Roger Williams Truesdail, "The vitamin A content of Pacific coast salmon body oils."

Wisconsin

Roy Herman Baechler, "A relationship between the chemical formula and the toxicity toward *Fomes annosus* of certain benzene derivatives." Warren Froemming Busse, "The decomposition of nitrogen pentoxide in the presence of foreign gases. The chemical action of cathode rays." Harry Eaton Carswell, "The relation of structure, affinity, and reactivity of ketones." Albert Smith Carter, "A study of furylangelic acid." Bernard Victor Christensen, "Prepared chalk and other forms of calcium carbonate." John Ray Faneslow, "Studies of the optical activity and relative resistance to shear of gelatin systems, and their influence upon the conception of jelly formation." Louis Carl Fleck, "Studies in the chemistry of wood." Lloyd Ervin Harris, "*Bixa oreliana* with special reference to the chemistry of the seeds." Gilbert Frederick Hoffmann, "A study of some derivatives of selenium and tellurium." Glenn Howe Joseph, "Light-scattering capacities in connection with the structure of gelatin gels and sols." Roy Fred Korfage, "The hygroscopicity of sugars and mixtures of sugars at various humidities, and its relation to the hard-candy problem." Harris Barnum Parmele, "Biochemical studies of sauerkraut." Robert Merrill Simington, "The catalytic oxidation of alcohols over metallic catalysts." Clarence Harvey Sorum, "Some studies with ferric oxide hydrosols." Rolla Williams Titus, "The nature of the protein surrounding the fat globule in milk." Edwin Odde Wiig, "A study of the decomposition of acetone dicarboxylic acid."

Yale

Albert Franklin Dolloff, "An explanation of salt antagonism based on the assumption of a purely quantitative difference between the action of various cations." Robert

Walker Eldridge, "Some new derivatives of atophan." Arthur Fleischer, "The adsorption of vapors by porous oxides." Elizabeth Gilman, "An improved method of synthesizing esters of mesoxalic acid and a study of the mechanism of the reaction." Verz Rogers Goddard, "Hema-glutinins of plant origin." Harvey Henry Harkins, "The examination of yeast nucleic acid for methyl-cytosine." Wilbie Scott Hinegardner, "A study of chaulmoogric acid with the object of ascertaining the cause of its therapeutic effect." Rebecca Barnett Hubbell, "A study of the rôle of zinc in nutrition." Charles Lester Lazzell, "The solubility relations of the isomeric amino-benzoic acids, and the synthesis of some new acyl derivatives." Alice Gertrude Renfrew, "Factors influencing the ease of formation of aldehyde-hydantoin condensation products of biochemical interest." Raphael Emory Rupp, "Indigoid derivatives of 2,4-diketotetrahydroquinoline." Luke Eby Steiner, "The development of a radiation calorimeter and its applicability to the measurement of the heat of fusion of some organic compounds."

Metric Urgers Launch Nationwide Campaign. With the approach of the new session of Congress advocates of decimal metric weights and measures for the United States have organized for an energetic campaign. Hon. Fred A. Britten of Illinois has announced that he will introduce a liberal Metric Standards Bill in the House of Representatives on the very first day of the new session.

At its recent convention at Lake Placid, the Metric Association outlined plans for greatly increased activity. The All-America Standards Council is also urging prompt legislative action by Congress, establishing the decimal metric units for general use in merchandising throughout the United States after 1935. Its executives announce that metric standardization is urged by Thomas A. Edison, John Hays Hammond, Samuel Vauclain, John J. Pershing, Theodore Roosevelt, Franklin D. Roosevelt, Arthur Capper, E. N. Hurley, William G. McAdoo, Roger Babson, and many others eminent in national affairs.

Led by such influential groups as the New Orleans Association of Commerce and the Washington Manufacturers Association, more than 300 important chambers of commerce and industrial organizations are urging liberal metric legislation.

Among other important organizations advocating the metric adoption are the National Wholesale Grocers Association, American Chemical Society, National Wholesale Druggists Association, Associated General Contractors of America, American Institute of Architects, National Congress of Mothers and Parent-Teacher Associations, Institute of Radio Engineers, and the National Research Council.

More than 100,000 petitions urging metric legislation have been placed before Congress, and as many of these are from large organizations, altogether they represent several million voters. The States of Illinois, California, Tennessee, North Dakota, and Utah are among those which through their legislatures have petitioned Congress to adopt the metric standards for all the people.

A metric victory was won at the recent Pan-American Standardization Conference at Washington, D. C. At its national convention at Grand Rapids, Michigan, the General Federation of Women's Clubs passed a resolution unanimously calling upon Congress to enact metric legislation. This organization has 3,000,000 members, and it is expected that they will participate actively in the new metric movement now being launched.

Correspondence

A CORRECTION

Mr. Neil E. Gordon,
Journal of Chemical Education,
College Park, Md.

Dear Sir:

We wish to call your attention to the glaring error on page 1087 of the September issue of your JOURNAL, in the abstract of an article by Dr. Alfred F. Hess which appeared in the July 30th number of the *Journal of the American Medical Association*. In the third paragraph you say, "The specific activity of the milk is maintained for a period of at least six weeks." Dr. Hess, in the conclusions of his article, says the specific activity of the milk is maintained for a period of at least six *months*.

You will well realize that a period of but six weeks would make the commercial possibilities of such a product improbable, whereas a period of at least six months makes them probable.

Our research laboratory, under the direction of Dr. G. C. Supplee, has been coöperating with Dr. Hess for over two years in the irradiation of dry milk. Our researches have shown that the activity of the milk is probably maintained indefinitely.

Yours very truly,

The Dry Milk Co.,
L. J. Auerbacher,
V. P & Mgr. Dryco Dept.

15 Park Row,
New York City

Emerson Was Interested in Development of Chemistry. Ralph Waldo Emerson, the great essayist, kept in close touch with the development of chemistry from the time he was a boy of seventeen until his old age, Dr. Charles Albert Browne told members of the American Chemical Society.

Emerson's journals and essays are filled with chemical references, said Dr. Browne, while he drew freely upon his knowledge of this science for many of his most striking analogies and comparisons.—*Science Service*

Chemical Digest

ABSTRACTS

Science as Culture. WILLIAM HAYNES. *Science*, **65**, 462–4 (May 13, 1927).—Inasmuch as only about 10 per cent of the undergraduates taking general chemistry pursue further chemical courses and only 2 per cent continue to post-graduate work, the author suggests that a foundation of chemical history and the philosophy of chemistry is better than the general first-year course. This course would be more cultural and at the same time serve to prevent overspecialization and to prepare the professional student with an appreciation of the nature of chemical problems. H. F. J.

On the Question of the Existence of Induction Effects from Suddenly Stopped Electrons Predicted from the Classical Theory. S. R. MILNER AND J. S. HAWNT. *Phil. Mag.*, **3**, 1185–95 (May, 1927).—Experiments have been made with various anodes on electrons moving in a vacuum in a metal cylinder and suddenly stopped by the anode. These experiments show no evidence of an e. m. f. being generated in the metal cylinder surrounding the anode. E. S. R.

Hardness of Alloys. A. MALLOCK. *Nature*, **119**, 664 (May 7, 1927).—A study of the hardness curves of alloys of copper with tin, zinc, cadmium, aluminum, antimony, and bismuth. Also a study of the coefficients of friction under high pressure tending to show that lubrication has no practical effect, the lubricant being probably completely squeezed out. H. K. M.

Surface Film of Aluminum. H. SUTTON AND J. W. W. WILLSTROP. *Nature*, **119**, 673–4 (May 7, 1927).—Evidence for the aluminum film is obtained. The aluminum in the form of thin sheets is cut into narrow strips, heated in an atmosphere of dry hydrogen to 300° and dry hydrochloric acid is then passed through the tube forming with the metallic aluminum exposed at the cut edges aluminum chloride which sublimes. Ultimately all the aluminum is removed and the surface films remain—extremely delicate, tending to curl and small in amount but apparently continuous. H. K. M.

The Theory of Strong Electrolytes. T. M. L. *Nature*, **119**, 676–8 (May 7, 1927).—A report of the discussion on "The Theory of Strong Electrolytes" organized by the Faraday Society at Oxford on April 22nd and 23rd. The theory of interionic attraction is based on the postulate that each negative ion in a solution is surrounded by a region containing an excess of positive ions and conversely. In electrolysis this atmosphere of ions is drawn through the solution and creates an increased frictional resistance by dragging the solvent with it. This atmosphere lags behind the ion under consideration and as soon as it begins to move a retarding electrostatic potential is set up; the strength will depend on the rapidity with which the excess of oppositely charged ions is dissipated in the rear of the moving ion and collected in the new region into which it is advancing. The resultant decrease in conductivity can be calculated and is proportional to the square root of the concentration. Kohlrausch's law can, therefore, be explained as due to variations of ionic mobility resulting from the phenomena of interionic attraction without requiring any variation in the number of ions involved in carrying the current. The results from the formulas of Debye and Hückel are not yet in precise numerical agreement with experiments although they may be improved by allowing for the Brownian movement, a modification introduced by Onsager. The theory has at least provided a physical basis for Kohlrausch's law but it is a disappointment to find the old warning repeated that the formulas now used are only valid in dilute solutions and that a close concordance between theory and experiment is not to be looked for in solutions of greater concentration than $N/100$ or $N/1000$. H. K. M.

Radio-activity and the Heat of the Earth. R. W. LAWSON. *Nature*, **119**, 703–4 (May 14, 1927).—A reply to Dr. Evans concerning the temperature gradient and the deep boring at Dubblelde Vlei. H. K. M.

Iron Crystals. L. W. MCKEEHAN. *Nature*, **119**, 705–6 (May 14, 1927).—Long, iron crystals have been grown by making use of the allotropic transformation which occurs at 900°C. The method is to heat a portion of the wire between two mercury contacts and then cause the heated portion to travel along the wire. Hottest part of the wire should be at 1400°C. or higher. H. K. M.

Microörganisms in Chemical Industry. I. (*a*) The Manufacture of Volatile Fuels

and Solvents. G. MALCOLM DYSON. *Chem. Age*, **16**, 571 (June 18, 1927).—The first of a series of articles on this subject. The study and use of microörganisms is essential in the production of many of the simpler organic compounds. The bacterial system of manufacture offers the advantages that it continues smoothly and evenly without much supervision or use of costly reagents, the yields are good, the product is pure or can easily be purified, and labor costs are usually low. The disadvantages are that bacteria and moulds are very sensitive organisms and require accurately controlled conditions, such as temperature, hydrogen ion, and proper nutrition. They cease growth when certain concentrations are attained, thus making for extensive equipment and high evaporation costs. There is also the danger of contamination by undesirable bacteria.

The mechanism of enzyme action is still obscure but it is much more specific than that of inorganic catalysts. "One enzyme, one job." The production of alcohol is the most extensive application of microbiology to industrial chemistry. Starch is converted to soluble starch, erythrodextrin, achroödextrin, and through various steps, to maltose and dextrose by the addition of 2 per cent malt, and then by yeast to alcohol. The presence of lactic acid bacteria is desirable because they produce an acidity which does not interfere with the action of the yeast but which inhibits the growth of various other organisms. About 90 per cent of the glucose is converted into ethyl alcohol, the rest forming higher alcohols, glycerol, acetic, propionic, and succinic acids and traces of aldehydes and esters. With pure yeast juice, neither higher alcohols nor succinic acid are produced during fermentation. D. C. L.

Microörganisms in Chemical Industry. I. (*b*) The Manufacture of Volatile Fuels and Solvents (continued). G. MALCOLM DYSON. *Chem. Age*, **17**, 32 (July 9, 1927).—The manufacture of alcohol from wood cellulose is not yet being carried out commercially. The cellulose cannot be converted readily into a soluble, easily fermentable form. Experimental work indicates that acid hydrolysis is too expensive at present. With hard wood 20 gallons of alcohol per ton were obtained compared to 80 gallons with grain. Microörganisms do not appear to offer a solution, the cellulose aggregates apparently being too large for their attack. An organism obtained from manure, which was claimed to be able to convert any form of cellulose, does not act successfully. In India, banana waste is fermented to hydrogen, methane, and carbon monoxide. Gas equal to 80 per cent of the volume occupied by the material is produced in 24 hours and continues at this rate for some time. It contains 85 per cent methane.

Acetone can be made from starch either by direct fermentation or by first forming calcium acetate and then distilling. By use of a special organism the products in the direct method are acetone and ethyl alcohol instead of butyric acid as formerly. A p_H of 8 favors the production of acetic and formic acids, while at 5–7 the formation of acetone and ethyl alcohol is favored. A ton of corn cobs yields 65 lb. acetone, 152 lb. alcohol, and 76 lb. mixed acids.

By the use of the lactobacillus they obtained from one ton of corn cobs 300 lb. acetic acid and 320 lb. lactic acid. During the war, seaweed was fermented to form acetic acid. Sugar can be converted to glycerin by fermentation, 1 ton producing 400 lb. glycerin, 550 lb. alcohol, and 100 lb. mixed aldehydes. D. C. L.

The State of Beryllium Production. (From an article on Beryllium by J. Becker in *Zeitschrift für Electrochemie* for May.) *Chem. Age*, **16**, 43 (June 4, 1927).—The value of the light metals for industrial purposes has been realized only comparatively recently. Beryllium is an element still lighter than aluminum, 1.85 as compared to 2.70, it is harder than glass and in some alloys is extremely malleable. It transmits X-rays 17 times better than aluminum. The known deposits at present are neither numerous or rich. The price of the metal has dropped from 200 marks to 6 marks per gram. About 120 grams are produced daily by a small experimental plant in Germany. It is expected as demand grows that the cost of production will drop just as in the case of aluminum. D. C. L.

Chemical Fire Extinguishers. W. R. ORMANDY. *Chem. Age*, **17**, 462 (May 14, 1927).—Methods of fighting fire are (1) the use of water to reduce the temperature at the source, (2) the production of heavy vapors, (3) the application of solid materials such as sand or earth or bodies giving off non-inflammable gases on heating, and (4) the foam method which is the most modern. In the class of heavy vapors the acid and soda process and carbon tetrachloride are used chiefly. The CCl_4 must be of unusual purity, free from moisture and CS_2 which cause corrosion, so that even after years of standing the extinguisher is still in excellent condition. The foam method consists in the addition of some organic substance to produce a foam to the carbon dioxide extinguisher containing sodium bicarbonate and aluminum sulfate. The use of methyl bromide in case of fire during the distillation of inflammable liquids is recommended

where expense is not an item. A tube of 25–50 cc. methyl bromide sealed off by a capillary makes a convenient laboratory extinguisher. By holding it in the hand and breaking the capillary the liquid is sufficiently heated to discharge itself. D. C. L.

Abolition of the Bureau of Chemistry. HARVEY W. WILEY. *Science*, **65**, 371–2 (Apr. 15, 1927).—The Bureau of Chemistry has been abolished by an act of Congress. Its work is to be divided between the newly established Food and Drugs Administration and Bureau of Soils. W. criticizes the method of Congress used in the abolition of the old bureau. H. F. J.

Adjusting Education to the Abilities and Needs of Students at the University of Akron. G. L. HAYES. *Sch. and Soc.*, **25**, 606–7 (May 21, 1927).—For some years past, it has been the policy of the University of Akron to exclude from the following semester all students who failed to pass a specified number of hours of work. In the interests of the university, the taxpayer, and the individual student, it was decided to reduce all failures to a minimum and to analyze their causes. Upon recommendation of the Psychological Research Committee of the university, the faculty now requires that all entering students take tests to determine the amount of work each may attempt to carry; that a student failing to pass a certain number of hours may return only by carrying a lighter schedule; that a student doing unsatisfactory work under the reduced load shall be dropped from classes.

By the above plan, it is hoped to discourage those students who take more work than they are capable of carrying. By furnishing each student with a schedule adapted to his individual needs and ability, he will be prepared to take his place in the community. K. S. H.

The Determination of Fitness for College. W. FARRAND. *Sch. and Soc.*, **25**, 592–6 (May 21, 1927).—The problem of selecting individuals who ought to go to college lies not with those of superior intelligence, or with those who have a serious purpose, but rather in the differentiation between the vast multitude who seem unable to find themselves and those of deficient mentality. Four tests for use in determining these qualities are discussed: the school record; College Board examinations; Scholastic Aptitude Tests; and human judgment. The future of anyone should not, however, depend on a numerical rating which is likely to result if these tests are treated too mechanically. Each method has its disadvantages, which the author explains in detail, but taken as a whole they serve as a fairly accurate means of judging a candidate. K. S. H.

Ozone in the Atmosphere of the American College. M. M. METCALF. *Sch. and Soc.*, **25**, 558–61 (May 14, 1927).—The author, through personal experiences, has become convinced of the importance of research by college faculties. It is the teacher with a spirit of research who is the most inspiring, and under whom the greatest advancement is made. The character, ability, and productive scholarship of the teaching staff in a college is of fundamental importance. K. S. H.

The Iodimetric Determination of Vanadium. J. B. RAMSEY. *J. Am. Chem. Soc.*, **49**, 1138–46 (May, 1927).—In an alkaline solution, or in a neutral buffer solution, tetravalent vanadium is oxidized by iodine to the pentavalent condition, while in acid solution pentavalent vanadium is reduced by iodide ion. At very high concentrations of acid and iodide, the reduction may be made to proceed to the trivalent condition, but under a very wide range of concentrations it proceeds only to the tetravalent stage. Several investigators have described methods for the estimation of vanadium in the pentavalent condition by determining the amount of liberated iodine. All of them find that unless air is excluded more iodine is liberated than the amount of vanadium present requires, and this is attributed to the catalytic action of the pentavalent vanadium on the oxidation of iodide to iodine by oxygen of the air. Recently Stoppel, Sidener, and Brinton published a short method which does not exclude the air and for which they claim accuracy. The author checks the method, and is unable to confirm their statements as to the precision to be attained, finding in every case more iodine when air is admitted. Tables of data are presented, and an accurate and rapid method excluding air is outlined. Determinations may be made in 15 minutes with an accuracy of 0.1 per cent. A. P. B.

The Use of Methoxytriphenyl Carbinols as One-Color Indicators. I. M. KOLTHOFF. *J. Am. Chem. Soc.*, **49**, 1218–21 (May, 1927).—The one-color indicators in use at the present time are colorless in acid solution and colored in alkaline solution. It would seem very desirable to have a series of indicators with exactly the reverse properties and such a series is here described. The author has used for this purpose several methoxy derivatives of triphenyl carbinol. Hydrolysis and basicity constants of three are listed fully, and for these three, hepta, hexa, and pentamethoxytriphenyl carbinol, he proposes the names of heptamethoxy red, hexamethoxy red, and pentamethoxy red.

The first of the three requires 15 minutes for complete color change and is, therefore, unsatisfactory for most purposes. The other two are entirely satisfactory in this respect and are shown, by titration data, to give accurate results and sharp end-points in acid-alkali titrations. A. P. B.

Transmutation of Hydrogen into Helium. F. PANETH. *Nature*, **119**, 706–7 (May 14, 1927).—The helium obtained in former experiments can now be explained without having recourse to the assumption of a synthesis of helium. It has been found that the liberation of helium from glass and asbestos is dependent on the presence of hydrogen. Glass tubes which gave off no detectable quantity of helium when they were heated in a vacuum or in oxygen were found to yield helium in quantities, the order of 10^{-9} cc. when heated in an atmosphere of hydrogen. A glass tube which has been completely freed from its content of helium by heating in hydrogen takes up a detectable amount of neon-free helium from the atmosphere even after only one day's contact with the air. H. K. M.

The Influence of Impurities on Copper. ANON. *Nature*, **119**, 728–9 (May 14, 1927).—Small amounts of bismuth adversely affect the rolling properties of copper; limiting percentages less than 0.01 per cent for hot rolling and 0.05 per cent for cold. Effects on the electrical conductivity and tensile strength are small. Copper containing up to 1 per cent arsenic will not produce sound castings; presence of a little oxygen greatly improves the casting properties. The copper arsenic alloys are exceedingly ductile and can be worked both hot and cold. Ratio of fatigue range to the tensile strength of arsenical copper is relatively high. Effect on the electrical conductivity is profound. H. K. M.

Mechanism of Knock Suppression. H. S. TAYLOR. *Nature*, **119**, 746 (May 21, 1927).—Not only does the lead tetraethyl act as an inhibitor of the oxidation of aldehydes but the fine particles of free metal and the free radicals function as catalysts of oxidation. The action of the free radicals may well account for the inhibitory effects produced by non-metallic knock suppressors of the type of aniline. H. K. M.

Some Properties of Coke. J. W. COBB. *Nature*, **119**, 751–3 (May 21, 1927).—The substance of two lectures delivered at the Royal Institution on March 29th and April 5th. H. K. M.

Essential Oils of the Eucalypts. J. READ. *Nature*, **119**, 784–5 (May 28, 1927).—An historical sketch giving an intimate picture of the habits of the eucalypts and the types of oils obtained. H. K. M.

Fat-Soluble Vitamins. ANON. *Nature*, **119**, 787–8 (May 28, 1927).—Vitamin D, the antirachitic vitamin, if not a sterol, is closely related to the group and it appears that ergosterol is the vitamin precursor. The sterols are widely distributed throughout the lower plants, thence they find their way into animals and the latter develop their own antirachitic vitamin upon exposure to light. Vitamin A is also related to, if not actually, a sterol. Here two entirely different lines of research have suddenly converged. The practical application of these researches in the prevention of rickets is obvious but this is not a very common disease. It appears that these vitamins play an important part in maintaining the various mucous membranes of the body in a healthy state. Also there is an important relationship between vitamin D and the formation and decay of the teeth which is now being actively investigated. H. K. M.

Transmutation of Elements. L. THOMASSEN. *Nature*, **119**, 813 (June 4, 1927).—The author has repeated experiments of Smits and Karssen. The currents compare with and even exceed those used by Smits and Karssen and as the dimensions of the tube are smaller the actual current densities are higher. On account of the smaller amounts of lead used the expected products of transmutation should be more easily detected but in spite of these two favorable conditions no transmutations could be found. H. K. M.

Personal Relations in the Small College. R. WALTERS. *Educ. Rev.*, 74, 40–1 (June 1, 1927).—The college may emphasize the social and democratic purpose of education, regarding it as training for citizenship, for public and economic usefulness or it may emphasize the intellectual, the scientific, the artistic with the Greek ideal of developing the independent human personality. The small college may combine parts of both ideals. As to mental hygiene all that may be expected of a small college is knowledge by advisers of the symptoms of these problems and alertness in referring students promptly to a physician, a psychologist or a psychiatrist. The small college knows her children not as a regimented host but one by one. Methods of improving relations are discussed and on the intellectual side there is a summary of Honors courses. H. K. M.

Salvaging the Seniors. A. R. HEDRICK. *Educ. Rev.*, **74**, 50–4 (June 1, 1927).—A

discussion of the conception that high-school teachers are hired by the community to bring all the children to a point of achievement warranting promotion and graduation. H. K. M.

Alas, the Composition of the College Freshman. M. RIGGS. *Educ. Rev.*, **74,** 54–6 (June 1, 1927).—The ability to handle with some accuracy the mechanics of written English has long been regarded as the most obvious sign of the educated man. This paper reports results with a series of diagnostic tests in the mechanics of English composition from the freshman English classes of a small college. An average of 7 per cent of these college freshmen scored below the norm for the seventh grade; 18 per cent scored below the norm for the ninth grade. These results compare with other institutions. Analyses are made and it should be easy to correct the faults. H. K. M.

Methods of Research. P. W. L. COX AND COMMITTEE. *Bur. Educ. Bull.*, **24,** (1926).—Topics treated include: meaning and purpose of research; method of research; the elements in research; "pure" and "practical" research workers; qualifications of the research worker; types of research; the questionnaire; and the report. In the classification of problems are found: the historic; the experimental; the philosophical and the survey type. A bibliography including forty-nine entries is a part of the bulletin.

While the publication is intended for educational research workers, it is also suggestive to a worker on a pure science problem. B. C. H.

The Titles and Abstracts of Papers Presented at the Washington Meeting of the National Academy of Sciences, April 25, 26, and 27, 1927. *Science*, **65,** 451–4 (May 6, 1927) and 478–80 (May 13, 1927).—The Effect of Tubercle Bacilli and the Chemical Fractions Obtained from Analysis on the Cells on the Connective Tissues in Rabbits, F. R. Sabin and C. A. Doan. The Effect of Small Amounts of Chemicals in Increasing the Life Activities of Plants, F. E. Denny. Physical, Chemical, and Biological Effects of High Frequency Sound-Waves, R. W. Wood. Relationships in the Spectra of the Elements of the First Row of the Periodic Table, R. A. Millikan and L. S. Bowen. Polarization of Light by Reflection from Rough Rock Surfaces, with Special Reference to the Materials Exposed at the Moon's Surface, F. E. Wright. The Variation of the Absorption of X-Rays with Wavelength, F. K. Richtmyer. Theory of Normal Cathode Fall, K. T. Compton and P. M. Morse. Special Distribution of the Photo-Electrons Ejected by X-Rays, E. C. Watson. Preliminary Revision of Rowland's Tables of Solar Spectrum Wave Lengths, C. E. St. John. Periodicity in Solar Radiation, C. G. Abbot. Differential Invariants of Irregular Elements, E. Kasner. Thermionic Emission and the "Universal Constant," A. E. H. Hall. Pressures in Discharge Tubes, W. H. Crew and E. O. Hulbert. Heats of Condensation of Positive Ions, and the Mechanism of the Mercury Arc, K. T. Compton and C. C. Van Voorhis. Magnetic Hydrogen Atoms and Nonmagnetic Hydrogen Molecules, W. A. Noyes. Relation of the Octet of Electrons to Ionization, W. A. Noyes. Boring for Natural Steam in California, A. L. Day. H. F. J.

Atomic Weight of Silver. H. B. BAKER AND H. L. RILEY. *Nature*, **119,** 703 (May 14, 1927).—A second reply to Brauner's criticism. Finely divided silver is heated in an electric furnace for one hour at 700–800°, one hour at 800–900° and five hours at 1000° while a slow stream of hydrogen is passed through the tube and bubbled through dilute nitric acid. The acid was tested for silver with potassium bromide by a nephelometer and no turbidity could be detected although 0.02 mg. of silver when added gave an immediate and comparatively dense turbidity. In the atomic weight determination the silver was heated for only 20 minutes and in a longer tube so that no silver could possibly have escaped. H. K. M.

The Relation of Temperature to Hydrogen-Ion Concentration of Buffer Solutions. A. G. OLSEN. *Science*, **65,** 477–8 (May 13, 1927).—O. emphasizes the importance of proper selection of buffer solutions where the reactions occur at temperatures other than that at which the acidity is measured. H. F. J.

Higher Endeavor in Science. M. I. PUPIN. *Science*, **65,** 509–11 (May 27, 1927).—An address delivered on the occasion of the laying of the cornerstone of an engineering building and a chemical laboratory at Princeton University, on May 12, 1927. H. F. J.

Precision Measurement of the K Series of Molybdenum and Iron. AXEL LAISSON. *Phil. Mag.*, **3,** 1136–60 (May, 1927).—An improved precision spectroscope has been constructed at the University of Upsala and used there for the precision determination of wave-lengths of the K series of molybdenum and iron. Every care has been taken so as to prevent the occurrence of any significant error in these measurements and the results tabulated. E. S. R.

The Magic Hour in Chemistry. C. E. BAER. *High-School Teacher.* **3,** 190–2;

240–1 (1927).—An article describing a series of experiments in chemical magic. References to books containing directions for such experiments are also given. B. C. H.

Approach to Absolute Zero. S. R. WINTERS. *Tycos*, **17**, 112–4 (1927).—A readable article describing methods used by H. K. Onnes of Holland and at the low-temperature laboratory under the direction of C. W. Konalt of the U. S. Bureau of Standards in attaining the freezing point of hydrogen and an approach to absolute zero. Dr. Onnes was within one and one-half degrees of it. The possibility of life continuing at such reduced temperatures and the unusual electrical properties of lead are discussed.
B. C. H.

Classification of Pupils: A New Faith. EDITORIAL. *School*, **38**, 88(1927).—Public schools have proceeded in the past upon the assumption that "all pupils are created free and equal." Some administrators and teachers are now challenging the efficacy of such a procedure and are demanding a grouping upon a plan recognizing bright, medium, and slow pupils. New York City is classifying her pupils according to ability. In the years 1922–24 thirteen schools in the city tried to so classify their pupils and experimented with content to suit individual needs. This classification has since been extended to practically every elementary school in the city.

The classification is made upon a basis of I. Q.'s and groups students into three groups: bright, I. Q. 110 or more; normal, I. Q. 90–109; slow, I. Q., 90 or below. Teachers report that the slow group seems to profit most from the differentiated treatment.
B. C. H.

The Productive Capacity of a University. CHAS. H. HERTY. *Science*, **66**, 25–7 (July 8, 1927).—The demand today is for research. Men and women trained in the methods of research are a necessary product of the university. The training of such advanced students also reacts wholesomely on undergraduate work. G. H. W.

A Protest against Cryptic Titles and Indirect Labeling of Figures. C. T. HURST. *Science*, **66**, 37–8 (July 8, 1927). G. H. W.

A Code of Ethics for Scientific Men. COMMITTEE ON SOCIAL AND ECONOMIC WELFARE OF SCIENTIFIC MEN, SOUTHWESTERN DIVISION, A. A. A. S. *Science*, **66**, 103–4, (July 29, 1927).—(1) Assume an obligation to do honest work and to impartially present the same to the public, regardless of political, economic, or religious prejudice, pressure or tradition.

(2) Exemplify in your conduct and work a courageous regard for the whole people, and not alone some powerful and influential fraction thereof with which you come in close personal contact.

(3) Recognize and assume a dual obligation, (*a*) to do the best possible work in your field, (*b*) to promote the social and economic welfare of your colleagues and yourself.

(4) Promote the dignity of your profession; avoid malicious criticism of colleagues; cultivate a professional consciousness.

(5) Support laws to insure competency and high standards on the part of scientific-technical men in every field.

(6) Respect yourself and your profession; do not underbid your colleagues; insist that the laborer is worthy of his hire.

(7) Be slow to change jobs and institutions where such a change means a loss of project efficiency, but do not hesitate to change where the attitude of autocratic superiors, miserably inadequate pay, or other conditions conducing to inexcusable inefficiency menace the entire service you are endeavoring to perform.

(8) Investigate before accepting a new position; do not become a candidate for any position from which the previous incumbent was unfairly or wrongly dismissed, or a position in any institution under the ban of dignified organizations of scientific men.

(9) Insist on such a measure of reasonable participation in the determination of policies in your institution as will best promote effective scientific work.

(10) Do not publish the work of colleagues or subordinates without giving full credit where credit is due; authorship should be determined on the basis of the responsibility for the ideas involved, conception and organization of the project, actual field or research work, and actual compilation and writing of the results.

(11) Avoid, alike, hasty and superficial publication, and the holding of real results indefinitely without publication.

(12) Take the public into your confidence; in the end the public pays the bills and has a right to know what is going on.

(13) Interest yourself in human concerns outside your specialty—politics, religion, economics—your obligation to serve the community along these lines is directly proportional to your training and real ability. G. H. W.

Local Activities and Opportunities

University of Florida. The opening of the fall semester will find the chemistry department installed in the new Chemistry-Pharmacy Building constructed during the past year. The completion of the addition, for which $130,000 has been provided, will make it one of the most commodious, completely equipped buildings of its kind in the south.

Dr. T. R. Leigh, head of the department of chemistry and Dean of the College of Pharmacy, has just returned from St. Louis where he attended the annual meeting of the National Pharmaceutical Association. He was elected chairman of the Chemistry Section.

Professors A. P. Black and F. H. Heath devoted the summer to supervising the installation of the new furniture and equipment in the new building. Professor Black acted as Dean of Men during the summer session.

Professor W. H. Beisler was engaged during the summer in special work in the laboratories of the Coronet Phosphate Company of Mulberry, Fla.

Associate Professor Jackson was a member of the faculty of the University Summer School.

Assistant Professor R. C. Goodwin has just returned from Cambridge, Mass., where he spent the summer in study and research at Harvard.

Curator B. J. Otte has just returned from a vacation spent in Northfield, Minnesota.

University Fellowships in Chemistry have been awarded to:

J. A. Ogg, B.S., U. of F., 1926.
S. K. Love, B.S., U. of F., 1927.
W. C. Setzer, B.S., Georgetown College, 1927.

Mr. Z. M. Pirenian, B.S., Ch.E., U. of F., 1926, majoring in chemistry, has just been elected instructor in mathematics at Alabama Polytechnic Institute, Auburn, Ala.

Mr. M. B. Matlack, who for the past two years has held the Citrus Fellowship at U. of F., has accepted a fellowship at U. of Wisconsin.

Mr. F. H. Babers, M.S., U. of F., 1927, majoring in chemistry, will be a teaching fellow at Princeton University this year.

Mr. L. B. Troxler, B.S.A., U. of F., 1927, majoring in chemistry, will be a research fellow at Rutgers University this year.

Wisconsin Teachers' Association. The Chemistry Section of the Wisconsin Teachers' Association will meet in Milwaukee the first week in November. Prof. P. W. Boutwell of Beloit College will speak on the subject of "What Should the Teacher Read?" and Dr. P. N. Leech, Director of the Chemical Laboratory of the American Medical Association, will speak on "Home Remedies, Claims vs. Composition." The Wisconsin chemistry teachers separated three years ago from the Chemistry-Physics Section and formed a separate organization.

University of Pittsburgh. Professor Alexander Silverman, head of the department of chemistry, University of Pittsburgh, gave an illustrated lecture on "Glass" before the Akron Section of the American Chemical Society, Thursday, September 29th.

Cleveland Section, A. C. S. The Cleveland Section of the A. C. S. will meet October 26th at 8:00 P.M. in the lecture room of the Physics Laboratory of Case School of Applied Science. Dr. W. J. Kelly, of the Goodyear Tire and Rubber Co., will speak on "The Constitution of Rubber."

Recent Books

Outlines of Theoretical Chemistry. FREDERICK H. GETMAN, Ph.D. John Wiley and Sons, New York, 1927. Fourth edition, revised and partly rewritten. xii + 728 pp. Number of figures 179. 14 × 21.5 cm. $3.75 net.

In the preface to the fourth edition of this well-known book the author lists the important changes: ". . . . a fuller treatment of limiting densities and vapor pressures; a brief description of the Mathew's method of measuring heats of vaporization; a more comprehensive treatment of crystal structure and of absorption of light in its bearing upon chemical constitution; a revision of the chapter on thermodynamics; a more discriminating treatment of osmosis; the inclusion of the concepts of fugacity and activity; a fuller discussion of the theories of emulsification and gel formation; an enlargement of the section devoted to adsorption and the preparation of colloids; a more detailed account of the theories of catalysis; the treatment of some practical applications of conductance and electrometric methods; a simplification of the treatment of hydrolysis; adoption of a uniform and consistent system for the representation of galvanic cells; a fuller treatment of both the hydrogen electrode and oxidation and reduction cells; a revision of the chapter on electrolysis and polarization; a brief presentation of the quantum theory; an outline of Baly's researches in the field of photosynthesis; and lastly, the complete revision of the chapter on atomic structure."

It seems unfortunate to the reviewer that the author has deemed it necessary to increase the number of pages over the third edition by more than 100. The author displays an intimate and enthusiastic knowledge of his subject, and it seems likely that this has led him into the error of making a book which is too inclusive to best serve the interests of a beginner in the subject. That is a matter of personal opinion. The author is not pedantic and the student is laudably impressed with the fact that the field of physical chemistry is much broader than the limits set for a textbook.

A number of minor criticisms are to be noted. A few errors have escaped the proof readers. The statement on page 7 that "we must not forget the fact that. . . . atoms are *purely* hypothetical" may seem to some as unwarranted caution. The student is not warned as regards the change of sign of heats of reaction when treating of them in the chapters on Thermochemistry and Elementary Principles of Thermodynamics. Much of the discussion on absorption of light following page 141 scarcely belongs in an elementary book. The derivation of the phase rule, page 394, is so brief and carelessly written that it might better have been omitted. Portions of the historical introduction in chapter 15 are discursive and inconsequential and should have been revised.

There is much to praise. With few exceptions the style is lucid and interesting. The author is at his best in the chapter on Colloids. References to the literature at the end of the chapters have been extended and include many recent citations. Some of the problems have been changed. The revision has greatly enhanced the value of the book in the matter both of wealth of material and in manner of presentation. Instructors will profit by its perusal and students will find it a stimulating guide in beginning and continuing their exploration into this superlatively important and rapidly expanding scientific vista.

F. L. SHINN

The Foundations of Nutrition. MARY SWARTZ ROSE, Ph.D., Professor of Nutrition, Teachers College, Columbia University. The Macmillan Company, New York City, 1927. xi + 501 pp. 86 figures and photographs. 12.5 × 19 cm. $2.75.

"This book is written for those who wish to live more intelligently," is the succinct statement of the author in her preface. She adds that "an effort has been made to present within a small space some of the fundamental principles of human nutrition in terms which call for no highly specialized training in those natural sciences upon which the science of nutrition rests."

The book is excellently and interestingly written, well arranged, and profusely illustrated. Several features are worthy of special mention. The free use of historical material in the introduction and throughout the book adds greatly to both its interest and its value. This is particularly true of the two splendid chapters on "The Vitamins." The material is carefully selected and embodies the most recent advances in this rapidly changing field. Book references are given at the end of each chapter and many references to the literature appear as footnotes throughout the book. In addition to many photographs, the author presents a wealth of valuable material in the form of tables, charts, and model menus, and there is an appendix of 9 tables.

The book is not only excellently adapted for use as a text or book of reference for beginner's courses, but may be read with pleasure and profit by all whose desire it is to "order their lives more successfully and have a better understanding of the part which nutrition plays in health in the world at large."

A. P. BLACK

Statistical Mechanics with Applications to Physics and Chemistry. RICHARD C. TOLMAN, Professor of Physical Chemistry and Mathematical Physics, California Institute of Technology—American Chemical Society Monograph Series—Chemical Catalog Company, Inc., New York, 1927. 334 pp. 15 × 23 cm. $7.00 net.

The writer has rendered a valuable service in bringing together in one place the laws and principles on which statistical mechanics is based and in giving them a clear and logical presentation. But the work is far more than one of reproduction and compilation. Besides a number of new contributions of importance, the writer's originality of viewpoint and critical treatment are in evidence throughout.

The book is divided into the following parts: Classical Statistical Mechanics, Introduction of the Quantum Theory, Application to Molecular Processes, Rate of Physical-Chemical Change and a Conclusion dealing principally with the relation of Thermodynamics to Statistical Mechanics.

Perhaps of most direct interest to the physical chemist is the section on Rate of "Physical-Chemical" Change, consisting of five chapters on: Velocity of Physical-Chemical Processes—Boltzmann's H-Theorem; Rates of Some Physical Processes—Transport Problems; Rate of Chemical Reaction; Temperature Coefficient of Reaction Rate; Photochemical Reactions.

Under the term "Physical-Chemical Change" are included the various physical processes involved in the chemical change. The entire treatment of reaction velocity is illustrative rather than exhaustive, and deals with questions where general agreement is still lacking. The reviewer cannot subscribe to the applicability of the general equation (No. 634, p. 290) for photochemical action, first advanced by Tolman in 1923: $-\frac{dN_A}{dt} = k_v u_v (N_A)^a (N_B)^b$. Mass action can have but a secondary rôle in photochemical action, if any; absorption does not follow such a law and since activation is not caused by collision, it is difficult to understand the applicability of the mass law.

After the extended application of the

quantum principle to chemical kinetics with reference to excited states it is surprising to find that the writer does not recognize that gaseous ionization (the limit of excitation) also represents a state of chemical activation where the quantum laws apply with equal force and where we have dozens of examples of validity proved to a degree that would be highly acceptable in photochemistry.

The book will prove of great value for reference and for advanced instruction in the special fields of physical chemistry and physical mechanics which it treats.

S. C. LIND

Elements of Chemistry. HARRY N. HOLMES, Professor of Chemistry, Oberlin College, and LOUIS W. MATTERN, Head Teacher of Chemistry, McKinley Technical High School, Washington, D. C. First edition. The Macmillan Co., New York, 1927. x + 519 pp. 257 figures. 13.5 × 19 cm. $1.80.

This new high-school chemistry comes of good parentage. A highly successful college teacher and the head teacher of chemistry in a large and well-known high school have combined their efforts and their wisdom in its production.

They have had the courage to leave out many non-essentials while retaining all the essentials and plenty of interesting applications. The outstanding feature of the book is its style. The authors have deliberately set themselves the task of interesting the pupil from the outset and their product should succeed in this respect.

We do not note many radical departures from the usual content of high-school texts. There are several changes in the order of development. For example, the authors have tried in several places to get good natural continuity of subject-matter. Air, nitrogen, ammonia, and nitric acid give us such an order. Again chlorine, hydrochloric acid, and the halogens form an orderly arrangement. All the organic chemistry is similarly arranged in a natural sequence. The reviewer is not so much impressed with the necessity of following any particular order as he is with the tremendous virtue of having a convincing relation between what has gone before and that which is to follow. An important function of the teacher is to impress such relationships upon his class and to keep them eagerly following the sequence of events.

It is notable that the first attempt to teach subatomic structure is made in the last chapter, which leaves it to the appendix to explain valence, oxidation, and reduction from the electronic standpoint. Perhaps the authors are wise in not being "the first by whom the new is tried" but if it is possible to teach the new chemistry to high-school pupils there seems to have been lost a great opportunity to use and to re-use the electronic notion.

Among many notably good features we list a splendid chapter on colloids, a fine one on fuels, one of the simplest explanations of the gas law corrections we have ever seen (in the appendix), some good suggestions for project work (also in the appendix), and a well-selected list of reference books which we note includes the well-known books published by the Chemical Foundation. Following this list we find, "Every laboratory should subscribe for the JOURNAL OF CHEMICAL EDUCATION," to which we can say "Amen."

Of course, all forward-looking high-school chemistry teachers will want to examine this text and we suspect not a few college teachers might catch a bit of inspiration from it.

F. B. WADE

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